CRT COLOR ANALYZER
CA-100

MINOLTA

The Minolta CRT Color Analyzer CA-100 is an advanced instrument designed to aid in the adjustment of the white balance of CRTs.

Measurements are taken simply by holding the measuring probe against the surface of the CRT; light emitted by the CRT phosphors and received by the measuring probe is measured continuously. Measured values can be displayed as x and y (chromaticity coordinates) and Y (luminance) values or as T (correlated color temperature), Δuv (color difference from blackbody locus), Y (luminance) values. Absolute measured values are displayed digitally; measured values are also displayed in analog form as a percentage of previously stored standard color data. Four different synchronization modes allow the CA-100 to measure virtually any CRT. These four modes are: NTSC (for measuring CRTs with a vertical scanning frequency of 60Hz, such as NTSC-system televisions), PAL (for measuring CRTs with a vertical scanning frequency of 50Hz, such as PAL- or SECAM-system televisions), EXT (for measurements utilizing an external synchronization signal), and UNIV. (for measuring CRTs with uncertain vertical scanning rates or for which a synchronization signal cannot be obtained). Eleven memory channels are provided for storing standard color data and calibration data for user-selected references. In addition, an RS-232C terminal is provided for data communication; measurement data can be output from the CA-100 to a separate computer and all functions of the CA-100 can be operated from the computer. Thus, the CA-100 can even function as part of a computerized production or quality-control system.

Optional accessories further expand the capabilities of the CA-100. Multi-Probe Expansion Board CA-A13 allows up to five measuring probes to be connected to the CA-100, enabling simultaneous measurements of multiple points on the CRT surface. GP-IB Interface Board CA-A20 can be installed for connecting the CA-100 to a GP-IB system, enabling the CA-100 to be used in a multi-device computer network. Memory Card CA-A14 and Multi-Probe Memory Card CA-A17 expand the memory of the CA-100 from 11 to 100 channels. Analyzer Card-G CA-A15 and Multi-Probe Analyzer Card-G CA-A18 add an analyzer (RBG) display mode based on G-beam standard to the CA-100 and also expand the memory to 100 channels. Analyzer Card-R CA-A16 and Multi-Probe Analyzer Card-R CA-A19 add an analyzer (RBG) display mode based on R-beam standard and also expand the memory to 100 channels.

This manual explains the operation of the Minolta CRT Color Analyzer CA-100 itself and operation with its accessories. Please read and study this manual thoroughly before using the CRT Color Analyzer CA-100 and/or its accessories for the first time, and keep this manual handy for future reference.

WARNING

- Read all safety and operating instructions before setting up or operating the CA-100.
- DO NOT USE THIS INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE, SUCH AS ONE CONTAINING GASOLINE FUMES. USE IN SUCH AN AREA MAY RESULT IN AN EXPLOSION.
- This instrument should be used only under the specified ambient conditions. See p. 14.
- The input plug of the AC Power Cord should be connected only to a grounded wall socket.
- This instrument should be powered only by a power source of the indicated rating. See p. 14.
- For protection, this instrument is equipped with a fuse. If this fuse needs replacement, use a fuse of the same type and rating (0.5A/250V time-delay fuse for 100-120V model; T 0.315A/250V time-delay fuse for 200-240V model).
  - Disconnect power input before replacing fuse.
- Do not disassemble this instrument or attempt to repair it yourself. This instrument consists of precise electronic components. Any necessary repairs should be performed only by an authorized Minolta service facility.

CONTENTS

DESCRIPTION....1
WARNING....2
CONTENTS....3
NAMES OF PARTS....5
Main Unit....5
Measuring Probe CA-A10....5
Standard Accessories....6
Optional Accessories....6
FUNCTIONS OF KEYS AND SWITCHES....8
On Front Surface....8
Under Keyboard Cover....9
On Rear Surface....10
INDICATIONS AND DISPLAYS....11
Display Mode Indications....11
SYNC Mode Indications....11
Digital Display....11
Analog Display....12
Liquid Crystal Display....13
Over-/Under-Range Indications....13
NOTES ON USE....14
PREPARATIONS....15
Attaching Probe Holder CA-A11....15
Connecting the Measuring Probe....15
Connecting External Synchronization Signal....16
* * Installing Optional Multi-Probe Expansion Board CA-A13....17
* * CONNECTING MEASURING PROBES TO MULTI-PROBE EXPANSION BOARD....18
* Inserting Optional Cards....19
Power....20
CONNECTING AC POWER CORD....20
SWITCHING POWER ON....20
SWITCHING POWER OFF....21
Selecting Luminance Unit....22
Selecting SYNC mode....22
Selecting Display Mode....24
* Selecting Probe Connector Number....25
ZERO CALIBRATION....26
SUPPLEMENTARY OPERATIONS....28
Memory Channels....29
SELECTING MEMORY CHANNEL....29
* WHEN USING OPTIONAL ACCESSORIES....29
Setting/Changing Standard Color Data....30
SETTING/CHANGING PROCEDURE....30
By Measurement....30
By Inputting Numerical Values....32
Calibration to a User-Selected Reference....33
CALIBRATION PROCEDURE....34
* * Setting RGB Emission Characteristics of CRT Phosphors....36
* SETTING PROCEDURE....36
Inputting ID Label....38
Setting Analog Display Range....39
FORMULAS....40
SETTING PROCEDURE....41
RELATION BETWEEN DIGITAL AND ANALOG DISPLAYS....41
Checking Stored Data....42
STANDARD COLOR DATA....42
CALIBRATION DATA....42
MEASURING PROBE SERIAL NUMBER....42
Serial Number of Measuring Probes Used For Setting Data....42
Serial Number of Measuring Probe Presently Being Used....43

* Procedures applicable only when using optional accessories

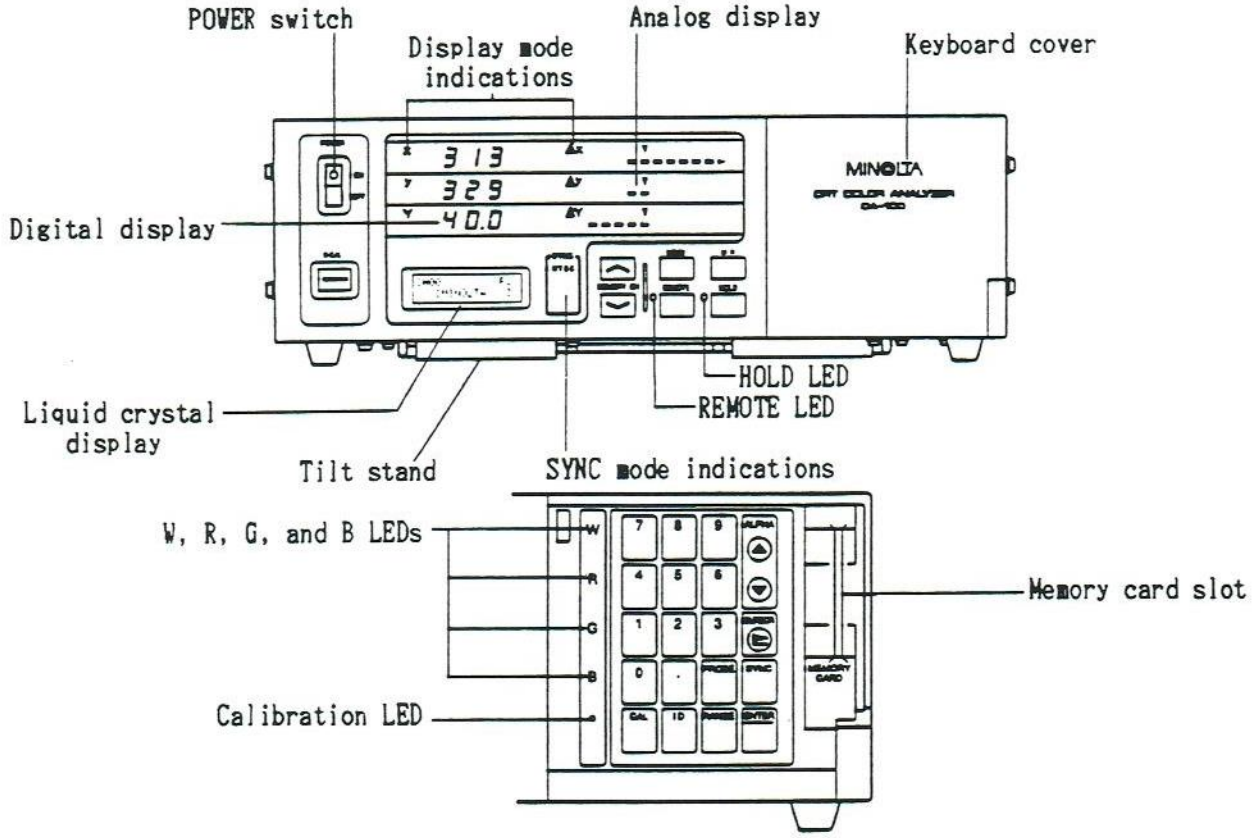
TAKING MEASUREMENTS....44
Display Hold....45
Displayed Data....45
DIGITAL DISPLAY....45
ANALOG DISPLAY....46
* WHEN USING AN OPTIONAL ANALYZER CARD....46
** ADJUSTING WHITE BALANCE USING ANALYZER (RBG) DISPLAY MODE....47
** Procedure....47
DATA COMMUNICATION....50
RS-232C Data Communication....50
CONNECTION WITH COMPUTER....50
COMMUNICATION PARAMETERS....51
Setting Baud Rate....51
COMMUNICATION PROCEDURE....52
Inputting Commands....52
Outputting Data....52
Operation During Data Communication....53
Sample Program....54
* GP-IB Data Communication....56
** INTERFACE METHOD....57
** INSTALLING OPTIONAL GP-IB INTERFACE BOARD CA-A20....58
** NOTES ON CONNECTING CA-100 TO GP-IB SYSTEM....59
** NOTES ON USING GP-IB SYSTEM....59
** SETTING ADDRESS....59
** COMMUNICATION PROCEDURE....60
** Inputting Commands....60
** Service Request....61
** Outputting Data....62
** Operation During Data Communication....63
** Sample Program....64
Communication Format....67
COMMANDS....67
OUTPUT DATA....72
Measurement Data....72
Data Recalled From Memory....74
Status Information....75
Error Messages....77
MEASURING PRINCIPLE....79
General Information....79
xyY Display Mode....80
TΔuvY Display Mode....81
Calibration to a User-Selected Reference....82
* Analyzer Mode....84
CARE AND STORAGE....86
FUSE REPLACEMENT....87
RACK INSTALLATION....87
DIMENSIONS....88
Main Body....88
Measuring Probe....88
ERROR MESSAGES....89
Determining Cause of Error Message "E1"....93
TROUBLESHOOTING GUIDE....95
* When Using Optional Multi-Probe Expansion Board....98
* When Using an Optional Memory Card or Analyzer Card....98
* When Using Optional GP-IB Interface Board CA-A20....99
SPECIFICATIONS....100

* Procedures applicable only when using optional accessories

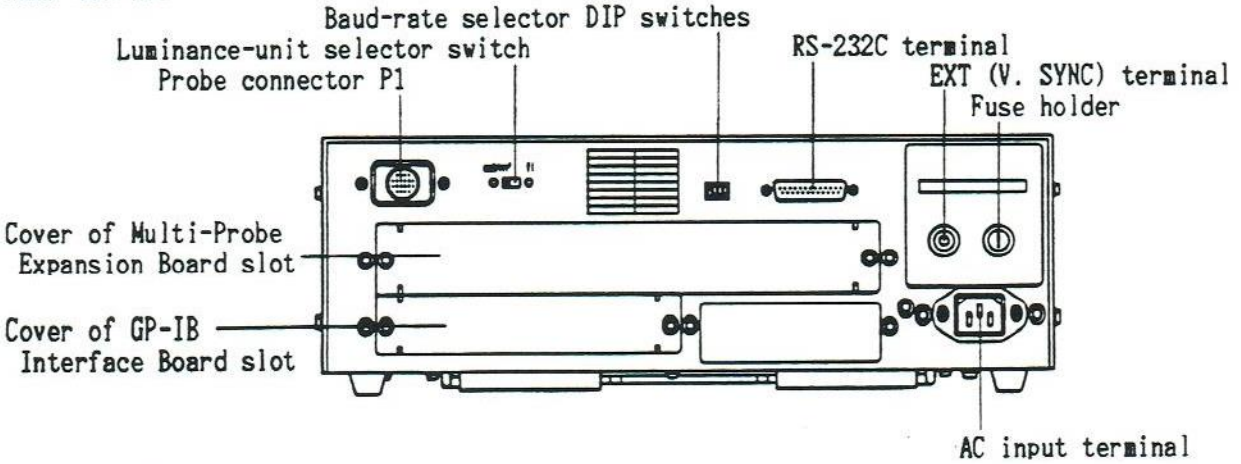
NAMES OF PARTS

Main Unit

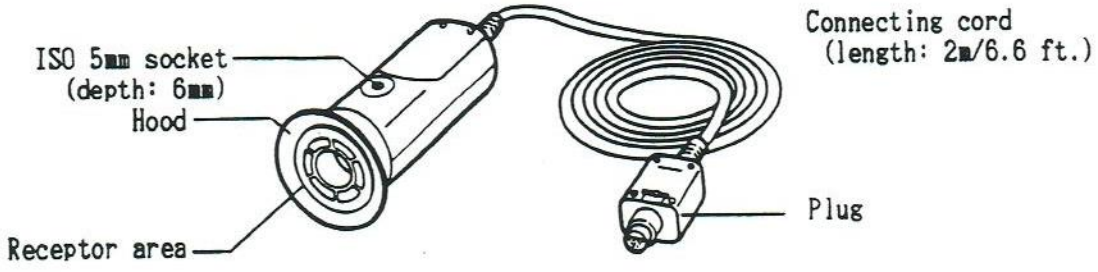
FRONT SURFACE



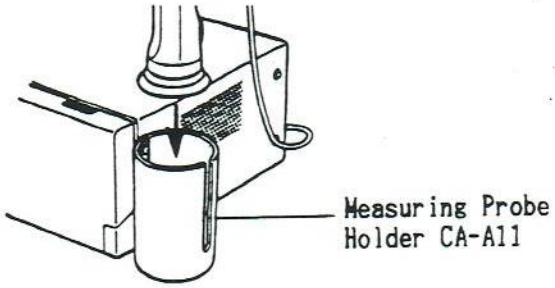
REAR SURFACE



Measuring Probe CA-A10

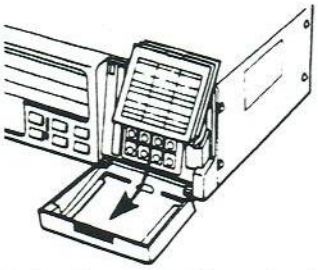


Standard Accessories



● Measuring Probe Holder CA-A11

● AC Power Cord
(Plug style may vary depending on country of purchase)



● Basic operation sheets (5 sheets; can be stored on inside of keyboard cover)

● Time-delay fuse
(0.5A/250V for 100-120V model;
0.315A/250V for 200-240V model)

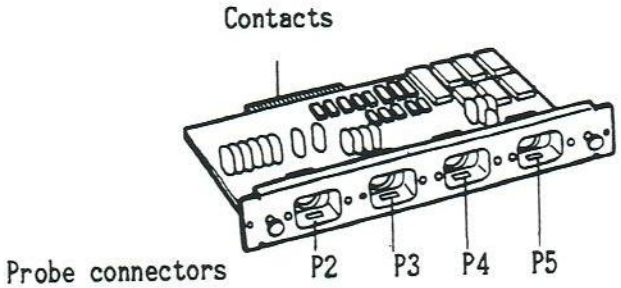
Optional Accessories

Note: This manual includes procedures for using these optional accessories as well as procedures for using the unit with only standard accessories. Procedures which apply only to use with optional accessories will be enclosed in a box.

● Measuring Probe CA-A10 (cord length: 2m/6.6 ft.)
● Measuring Probe CA-A12 (cord length: 5m/16.4 ft.)

These measuring probes can be connected to the probe connector of the main unit or any of the probe connectors of the optional Multi-Probe Expansion Board CA-A13.

● Multi-Probe Expansion Board CA-A13
This board allows the use of four additional measuring probes (for a total of five) for simultaneous measurement of multiple points.



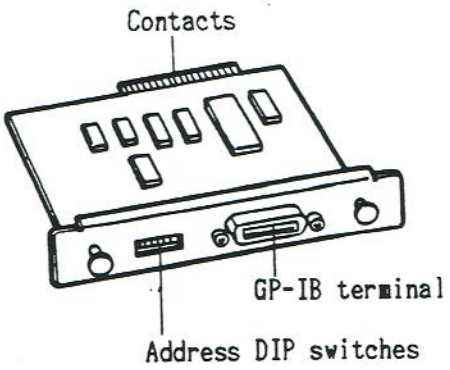
● Cards

Six different cards are available for the CA-100. Each card can be inserted into the memory card slot for use.

- In this manual:
  "Memory Card" refers to Memory Card CA-A14 or Multi-Probe Memory Card CA-A17.
  "Analyzer Card" refers to Analyzer Card-G CA-A15, Analyzer Card-R CA-A16, Multi-Probe Analyzer Card-G CA-A18, or Multi-Probe Analyzer Card-R CA-A19.

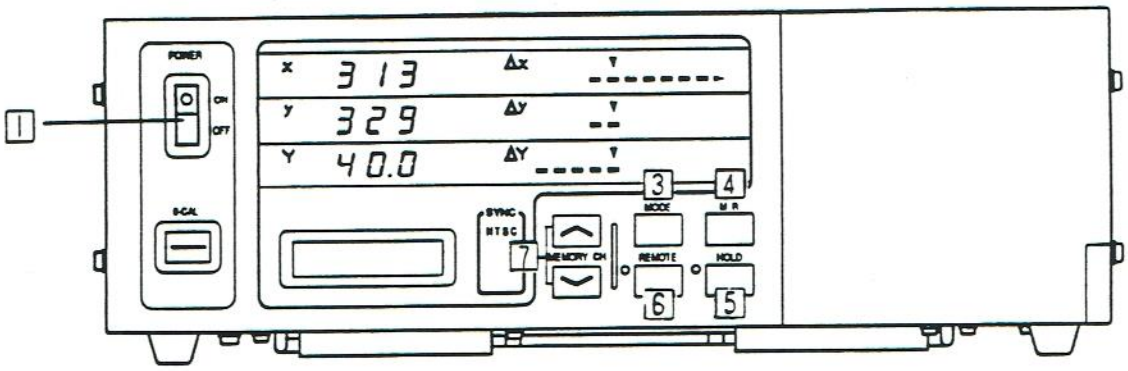
Card name	Function
Memory Card CA-A14	Provides 89 additional memory channels.
Analyzer Card-G CA-A15	Provides analyzer function (green standard) and 89 additional memory channels.
Analyzer Card-R CA-A16	Provides analyzer function (red standard) and 89 additional memory channels.
Multi-Probe Memory Card CA-A17	Provides 89 additional memory channels; for use with Multi-Probe Expansion Board.
Multi-Probe Analyzer Card-G CA-A18	Provides analyzer function (green standard) and 89 additional memory channels; for use with Multi-Probe Expansion Board.
Multi-Probe Analyzer Card-R CA-A19	Provides analyzer function (red standard) and 89 additional memory channels; for use with Multi-Probe Expansion Board.

● GP-IB Interface Board CA-A20
Allows CA-100 to be connected to and used with the IEEE-488 GP-IB (general-purpose interface bus) for data communication and computer control.



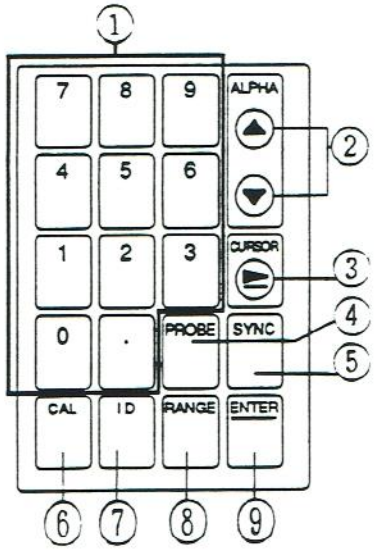
FUNCTIONS OF KEYS AND SWITCHES

On Front Surface



1	POWER switch	Switches power on and off.
2	0-CAL	Performs zero calibration.
3	MODE	Selects display mode. Display mode changes in the following order: xyY → TΔuvY → [analyzer (RBG)* →] xyY → ... * Analyzer (RBG) available only with optional Analyzer Card.
4	M R	Recalls previously set standard color data to the liquid crystal display. If held pressed when **PROBE** is pressed in xyY or TΔuvY display mode, displays serial number of the probe in use at the time calibration to a user-selected reference was performed and standard color data were set. If held pressed when **PROBE** is pressed while optional Analyzer Card is being used with analyzer (RBG) display mode selected, displays serial number of the probe in use at the time RGB emission characteristics of CRT phosphors and standard color (W) were set.
5	HOLD	Holds presently displayed data in display (HOLD LED will light) if pressed once; cancels display hold (LED will become not lit) if pressed again. ● If **ENTER** is pressed while display hold is set, data held in display will be set as standard color data.
6	REMOTE	Sets CA-100 for remote control via RS-232C terminal (REMOTE LED will light) if pressed once; cancels remote-control mode (LED will become not lit) if pressed again. ● Once remote-control mode has been set, pressing any key except **REMOTE** will have no effect on CA-100 operation.
7	MEMORY CH ∧and∨	Selects memory channel (00 through 10 standard; 00 through 99 with optional Memory Card or Analyzer Card). ∧selects memory channel in increasing numerical order; resets to memory channel 00 if pressed while highest memory channel (10 or 99) is displayed. ∨selects memory channel in decreasing numerical order; resets to highest memory channel (10 or 99) if pressed while memory channel 00 displayed.

Under Keyboard Cover



① Number keys (0 through 9 and .) — Inputs numbers or decimal point for calibration data of user-selected reference, standard color data, value of analog display range, or ID label.

② **ALPHA ▲**
ALPHA ▼ — Selects letters, hyphen, or space for inputting ID label. Selected letter changes by one each time either key is pressed; selected letter changes rapidly if key held pressed.
ALPHA ▲ selects letters in alphabetical order; selects hyphen ("-") and then a blank space (" ") after "Z"; selects "A" after blank space.
ALPHA ▼ selects letters in reverse alphabetical order; selects a blank space (" ") and then a hyphen ("-") after "A"; selects "Z" after hyphen.

③ **CURSOR ►** — Selects position when inputting calibration data of user-selected reference, standard color data, value of analog display range, or ID label. Moves cursor to next character space when pressed once; moves cursor continuously when held pressed.
If held pressed when **ENTER** is pressed, sets presently selected memory channel, display mode, SYNC mode, and probe connector number as the default settings (the settings which will be automatically selected when POWER switch is first set to **ON**).

④ **PROBE** — Displays serial number of probe in use.
If pressed while optional Multi-Probe Expansion Board CA-A13 is being used, selects probe connector number.
If pressed while **M R** is held pressed in xyY or TΔuvY display mode, displays serial number of the probe in use at the time calibration to a user-selected reference was performed and standard color data was set.
If pressed while **M R** is held pressed and optional Analyzer Card is being used with analyzer (RBG) display mode selected, displays serial number of the probe in use at the time RGB emission characteristics of CRT phosphors and data of standard color (W) were set.

⑤ **SYNC** — Selects SYNC (measurement synchronization) mode; mode changes in the following order:
NTSC → PAL → EXT → UNIV. → NTSC → ...

⑥ **CAL**

If pressed while memory channel 00 is selected, sets CA-100 for numerical input of standard color data.
If pressed while memory channel other than 00 is selected, sets CA-100 for numerical input of calibration value of user-selected reference.
If pressed while optional Analyzer Card is being used and analyzer (RBG) display mode is selected, sets CA-100 for input of RGB emission characteristics of CRT phosphors.

⑦ **ID**

Sets CA-100 for input of identification (ID) label for memory channel.

⑧ **RANGE**

Sets CA-100 for changing value of analog display range.

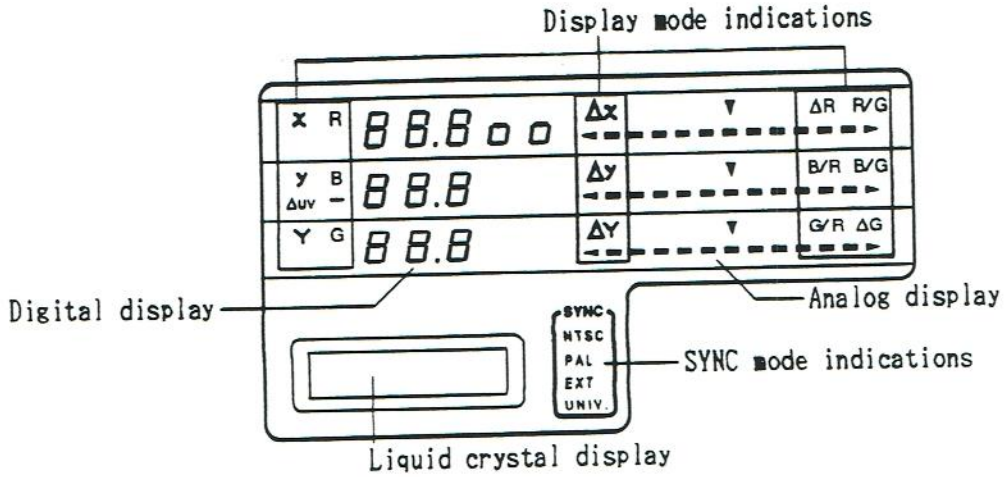
⑨ **ENTER**

Stores input data (calibration data of user-selected reference, standard color data, value of analog display range, or ID label) in memory.
If pressed while display hold is set, sets data held in display as standard color data.
If pressed while **CURSOR** ▶ is held pressed, sets presently selected memory channel, display mode, SYNC mode, and probe connector number as the default settings (the settings which will be automatically selected when POWER switch is first set to **ON**).

On Rear Surface

1. Luminance-unit selector switch — Selects luminance unit: cd/m^2 or fL.
2. Baud-rate selector DIP switches — Selects baud rate for data communication via RS-232C terminal.

INDICATIONS AND DISPLAYS



- All possible indications are shown in the figure above. During operation, only the appropriate indications will be shown.

Display Mode Indications

The selected display mode is indicated by the letters appearing next to the measurement data in the digital and analog displays.

Display mode	Indications	
	Digital	Analog
xyY	"x", "y", "Y"	"Δx", "Δy", "ΔY"
TΔuvY	"T", "Δuv", "Y"	"Δx", "Δy", "ΔY"
Analyzer (RBG)*	"R", "B", "G",	"R/G", "B/G", "ΔG" for green standard
	"R", "B", "G",	"ΔR", "B/R", "G/R" for red standard

* **Analyzer (RBG) display mode available only with optional Analyzer Card.**

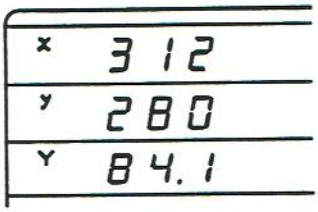
SYNC Mode Indications

The selected SYNC (measurement synchronization) mode is indicated by the lit mode indication: "NTSC", "PAL", "EXT", or "UNIV."

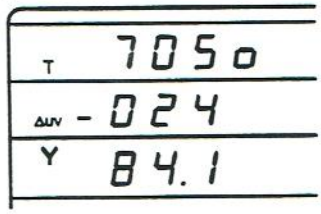
Digital Display

Numerical measurement values are shown in the digital display according to the display mode selected.

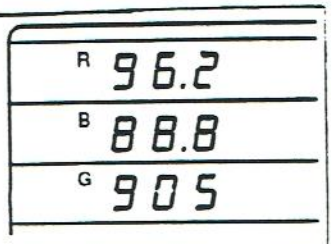
In xyY display mode, values for x and y (chromaticity coordinates) and Y (luminance) are displayed. The displayed values for x and y are 1000 times the actual value.



In TΔuvY display mode, values for T (correlated color temperature), Δuv (color difference from blackbody locus) and Y (luminance) are displayed. The displayed value of the correlated color temperature has three significant figures; the fourth and fifth figures are always zero. The displayed value of Δuv is 1000 times the actual value.



In analyzer (RBG)* display mode, values for measured R, B, and G (red, blue, and green intensities) as a percentage of the R, B, and G intensities of the standard color are displayed. If the values are 1000% or greater, a multiplication factor ("X10" or "X100") will be shown in the liquid crystal display.

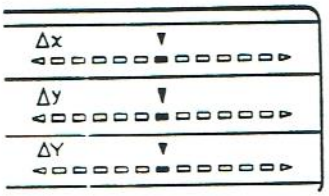


* Analyzer (RBG) display mode is available only with optional Analyzer Card.

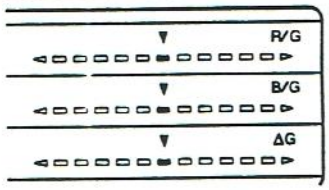
Analog Display

The percent differences between the measured data and the standard color data or between two values of measured data are indicated by the analog display according to the selected display mode as shown below.

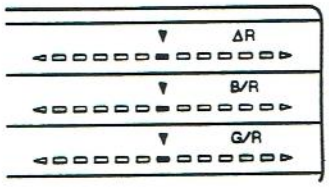
In xyY or TΔuvY display mode, values for Δx, Δy, and ΔY are displayed.



In analyzer (RBG)* display mode when using optional Analyzer Card-G CA-A15 or Multi-Probe Analyzer Card-G CA-A18, values for R/G, B/G, and ΔG will be displayed.

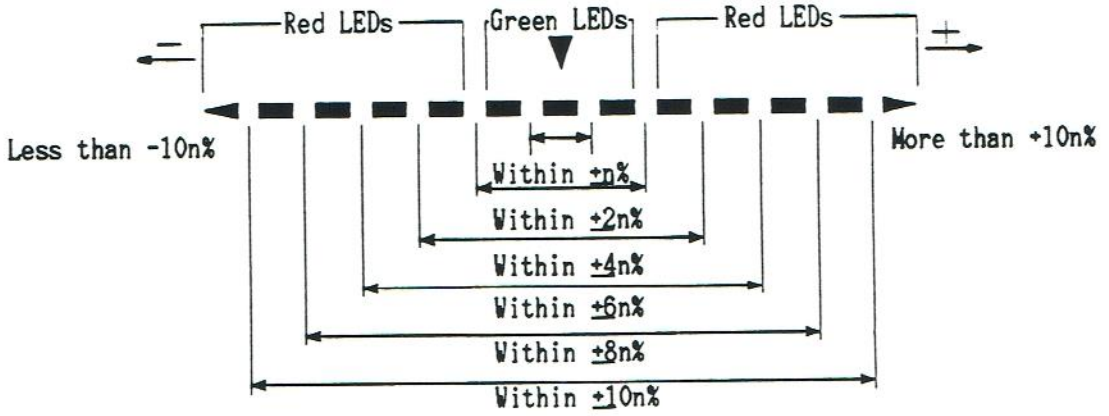


In analyzer (RBG)* display mode when using optional Analyzer Card-R CA-A16 or Multi-Probe Analyzer Card-R CA-A19, values for ΔR, B/R, and G/R will be displayed.



* Analyzer (RBG) display mode is available only with optional Analyzer Card.

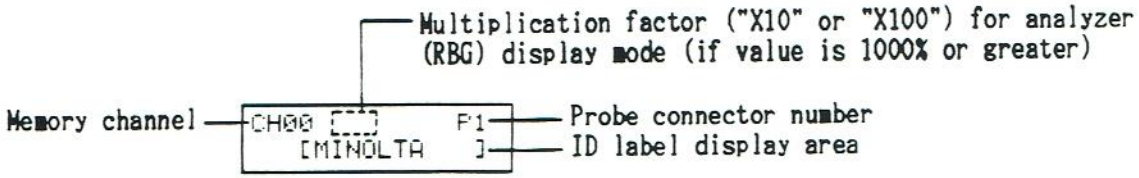
The value of the analog display range is the value for the central dot. For an analog display range value of n, the LEDs of the analog display indicate the values shown below.



The value of the analog display range is set to 10 at the time of shipment. It can be set between 0.1% and 99% according to the procedure on p. 39.

Liquid Crystal Display

The liquid crystal display shows a variety of information, such as present memory channel, present probe connector number, ID label, error messages, set or stored values, and multiplication factor, depending on the present operating state.


Multiplication factor ("X10" or "X100") for analyzer (RBG) display mode (if value is 1000% or greater)
Memory channel
CH00 [---] P1
[MINOLTA]
Probe connector number
ID label display area

Over-/Under-Range Indications

Indication		Meaning
Digital display:	"---"	Over measurement range
Analog display:	No display	
Liquid crystal display:	"OVER"	
Digital display:	Blinking	Y (luminance) is less than 0.19cd/m^2 or 0.06 fL when taking measurements based on Minolta's calibration standard
Digital display (T or Δuv area):	"---"	T or Δuv beyond display range

NOTES ON USE

- The CA-100 has been tested and found to withstand the following conditions. It should be used only in areas which do not exceed these conditions.

Operating temperature range	0 to 40°C/32 to 104°F
Storage temperature range	-20 to 55°C/-4 to 131°F (For optional cards: -10 to 55°C/14 to 131°F)
Humidity	Less than 85% at 35°C/95°F with no condensation
Impact resistance	10G (X, Y, and Z; 3 times in each direction)
Vibration resistance	2G (X, Y, and Z; 30 minutes at 16.7Hz in each direction)
Dielectric withstand voltage	1.0kV for 100-120V model; 1.5kV for 200-240V model
Insulation resistance	10MΩ
Static electricity	Main unit: 5kV Measuring probe: 15kV
Line noise	1.0kV
Leakage current	Less than 0.5mA
Service interruption	20ms
Voltage range	90 to 132V AC for 100-120V model; 180 to 264V AC for 200-240V model

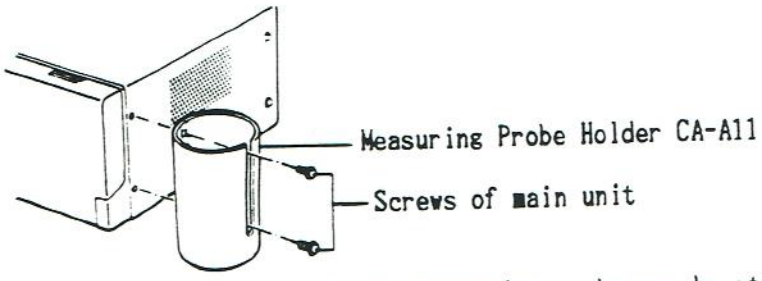
- Do not use or leave this instrument in direct sunlight or near sources of heat, such as stoves, strong lights, etc. Using or leaving this instrument in such locations may cause damage to internal components, since the internal temperature of the instrument may become much higher than the ambient temperature. Also, do not cover the ventilation holes of this instrument or use this instrument in poorly ventilated areas.
- Do not use this instrument in areas subject to quick variations in temperature. Use in such areas will not yield accurate results.
- Do not use this instrument in extremely dusty or extremely humid areas.
- Be extremely careful to keep water or metallic objects from entering this instrument. If water or a metallic object does enter this instrument, do not use this instrument until the water or metallic object has been removed.
- To avoid damaging the probe connecting cord or AC power cord, do not pull on, sharply bend, or apply strong force to either cord. When disconnecting either cord, pull on the plug, not the cord.
- This instrument should be used with a power source which is free of electrical noise.
- If this instrument is installed in a rack, be sure that the rack is strong enough to support this instrument and that there is sufficient ventilation.
- If a malfunction occurs, switch off the power immediately, unplug the AC power cord, and check for possible causes for the problem according to the troubleshooting guide on p. 95.

PREPARATIONS

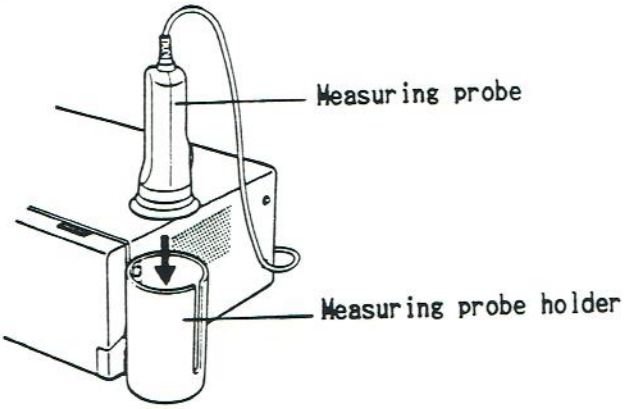
Attaching Measuring Probe Holder CA-A11

Measuring Probe Holder CA-A11 should be attached to the CA-100 as shown below.

- The measuring probe holder can be attached to either side of the CA-100.



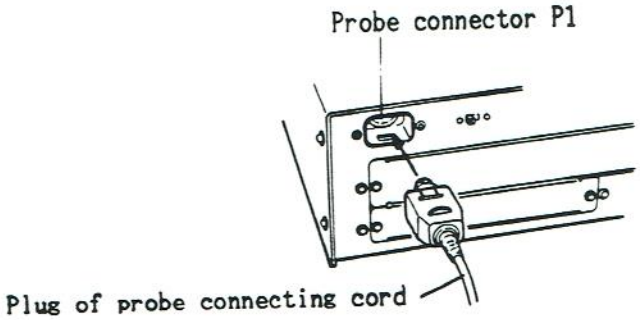
Once the measuring probe holder has been attached, the measuring probe can be stored in the measuring probe holder as shown below.



Connecting the Measuring Probe

Before switching on the power, connect the measuring probe according to the following procedure.

1. Check that the POWER switch is set to **OFF**.
2. With the probe serial number facing down, insert the plug of the probe connecting cord into probe connector P1 until it cannot be inserted any further.



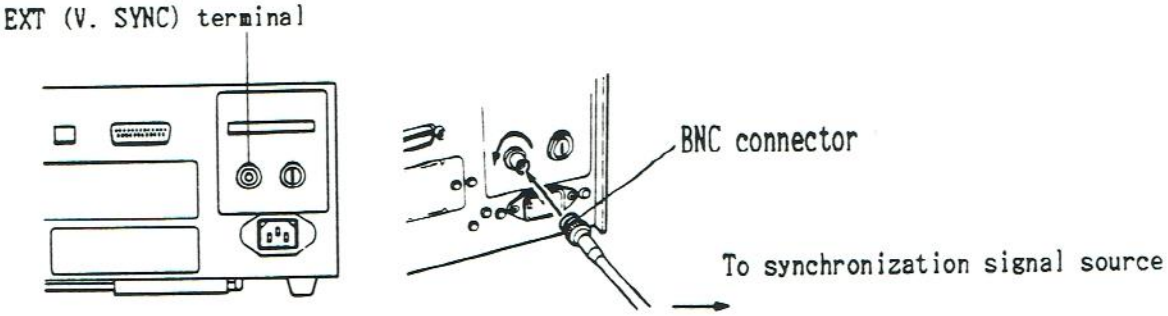
* When disconnecting the measuring probe, set the POWER switch to **OFF** and pull the plug straight out of the probe connector. Do not pull on the connecting cord.

Connecting External Synchronization Signal

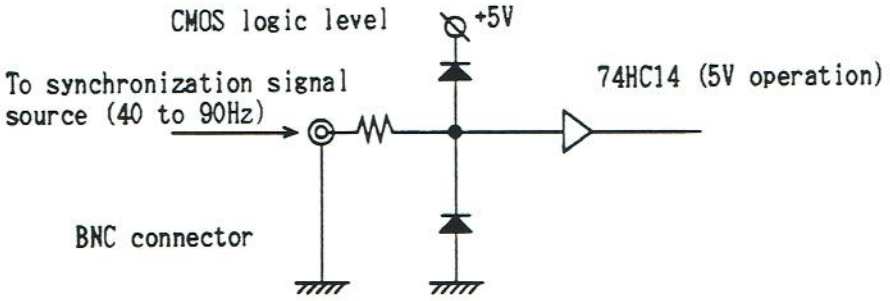
- When SYNC mode is set to NTSC, PAL, or UNIV., it is not necessary to input an external synchronization signal.

An external synchronization signal is necessary for measurements when the SYNC mode is set to EXT. By inputting the synchronization signal (40 to 90Hz) of the CRT to be measured into the CA-100, measurements can be performed in synchronization with the scanning of the CRT.

1. Check that both the CA-100 and the synchronization signal source are switched off.
2. Using a cable equipped with a BNC connector, connect the output of the sychronization signal source to the EXT (V. SYNC) terminal on the back of the CA-100 as shown below.



CIRCUIT DIAGRAM



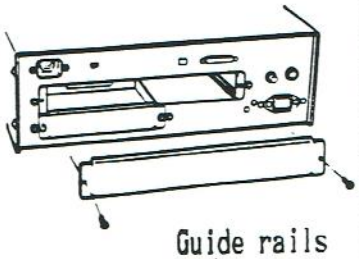
Installing Optional Multi-Probe Expansion Board CA-A13

By using the optional Multi-Probe Expansion Board CA-A13, it is possible to use up to five measuring probes for simultaneous measurements of five points on the CRT.

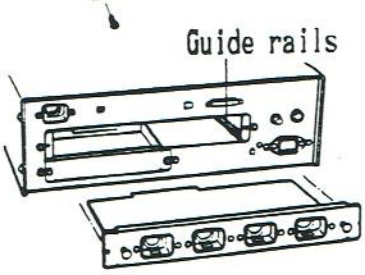
- Do not touch the gold contacts or any of the components on the Multi-Probe Expansion Board. If the contacts become dirty, wipe them with a soft dry cloth.

1. Set POWER switch to OFF.

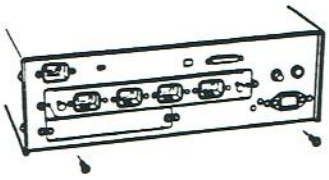
2. Using a Phillips (cross-point) screwdriver, remove the two screws of the cover of the expansion-board slot by turning them counterclockwise, and then remove the cover.



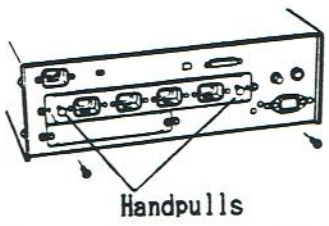
3. Align the edges of the Multi-Probe Expansion Board with the grooves in the guide rails on each side of the Multi-Probe Expansion Board slot and slide the Multi-Probe Expansion Board fully into the slot in a straight line. Check that the board is firmly in place.



4. Insert one screw in the hole on each side of the Multi-Probe Expansion Board and tighten until snug.

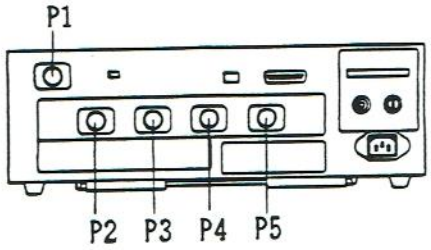


- To remove the Multi-Probe Expansion Board, switch off the power and unplug the AC power cord, remove the two screws holding the Multi-Probe Expansion Board in place, grasp the handpulls of the Multi-Probe Expansion Board, and pull the board out of the slot in a straight line. After removing the Multi-Probe Expansion Board, be sure to replace the cover of the Multi-Probe Expansion Board slot.



CONNECTING MEASURING PROBES TO MULTI-PROBE EXPANSION BOARD

Two types of measuring probes are available as optional accessories and can be connected to the Multi-Probe Expansion Board. Measuring Probe CA-A10 has a connecting-cord length of 2m/6.6 ft.; Measuring Probe CA-A12 has a connecting-cord length of 5m/16.4 ft.



When using the Multi-Probe Expansion Board, it is necessary to have a probe connected to probe connector P1. Other probe connectors can be used in whatever order desired. It is not necessary to use other probe connectors in numerical order.

Probes should be connected to the Multi-Probe Expansion Board according to the procedure below.

1. Check that the POWER switch is set to **OFF**.
2. With the probe serial number facing down, insert the plug of the probe connecting cord into the probe connector until it cannot be inserted any further.

- When disconnecting the measuring probe, set the POWER switch to **OFF** and pull the plug straight out of the probe connector. Do not pull on the connecting cord.
- Be sure to cover any unused probe connectors with the caps included.

Inserting Optional Cards

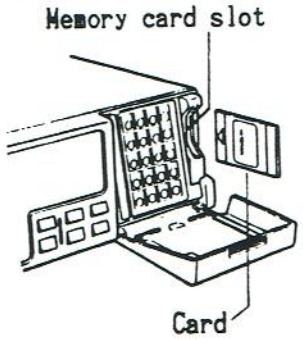
The six different optional cards available for the CA-100 are:

Card name	Function
Memory Card CA-A14*	Provides 89 additional memory channels.
Analyzer Card-G CA-A15*	Provides analyzer function (green standard) and 89 additional memory channels.
Analyzer Card-R CA-A16*	Provides analyzer function (red standard) and 89 additional memory channels.
Multi-Probe Memory Card CA-A17	Provides 89 additional memory channels; for use with Multi-Probe Expansion Board.
Multi-Probe Analyzer Card-G CA-A18	Provides analyzer function (green standard) and 89 additional memory channels; for use with Multi-Probe Expansion Board.
Multi-Probe Analyzer Card-R CA-A19	Provides analyzer function (red standard) and 89 additional memory channels; for use with Multi-Probe Expansion Board.

* Memory Card CA-A14, Analyzer Card-G CA-A15, and Analyzer Card-R CA-A16 cannot be used with more than one probe. Thus, if optional Multi-Probe Expansion Board CA-A13 has been installed and a probe is connected to any of the board's probe connectors (P2 through P5), these cards cannot be used. However, if no probe is connected to the board's probe connectors, these cards can be used even if the Multi-Probe Expansion Board has been installed.

To insert any of these cards, follow the steps below.

1. Set POWER switch to OFF.
2. With the card positioned as shown in the diagram at right, insert the card fully into the memory card slot until it cannot be inserted any further.

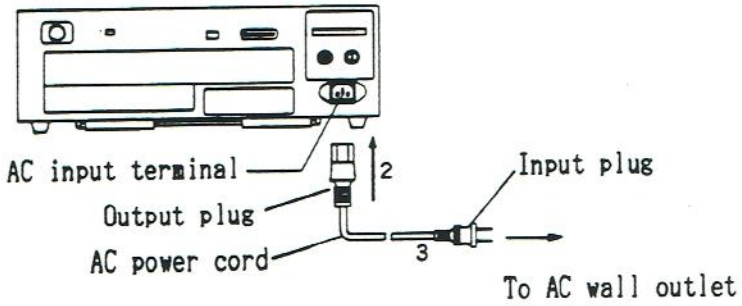


- Never insert or remove a card while the CA-100 is switched on.
- Check the position of the card carefully before inserting. The card can be inserted in only one position. Do not try to force the card into the slot. If it is difficult to insert the card, check again that the card is positioned correctly.
- Do not drop or bend the card or subject it to strong shock or force.
- Be extremely careful to prevent anything, such as dust, moisture, oil, etc. from entering the connector of the card. If anything enters the connector of the card, faulty connection and/or malfunction may occur.
- Do not use or store the card in areas subject to static electricity or excessive electrical noise. Use or storage in such areas may result in data loss.
- Do not use memory cards other than those sold by Minolta as optional accessories for the CA-100.

Power

CONNECTING AC POWER CORD

- This instrument should be used only with the rated power supply: AC 100 to 120V, 50/60Hz for North America; AC 200 to 240V, 50/60Hz for Europe.



1. Check that the POWER switch is set to **OFF**.
2. Insert the output plug of the AC power cord into the AC input terminal of the CA-100. The output plug can be inserted in only the position shown in the diagram.
3. Insert the input plug of the AC power cord into the appropriate AC wall outlet.

- When disconnecting the AC power cord, set the POWER switch to **OFF** and pull the output plug straight out of the AC input terminal. Do not pull on the cord.

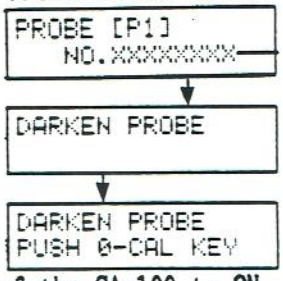
SWITCHING POWER ON

Before switching power on, check that the measuring probe is connected to probe connector P1. Also check the following points if applicable.

- If an external synchronization signal will be used, also check that the synchronization signal source is connected to the CA-100's EXT (V. SYNC) terminal (see p. 16).
- If multiple measuring probes will be used, also check that the optional Multi-Probe Expansion Board CA-A13 is installed and that the desired measuring probes are connected (see p. 17).
- If any of the optional cards will be used, check that the card is inserted (see p. 19).
- If data communication via the RS-232C terminal will be performed, check that the separate computer is connected to the RS-232C terminal (see p. 50) and that the baud-rate selector DIP switches are set correctly (see p. 51).
- If data communication via the optional GP-IB Interface Board CA-A20 will be performed, check that the GP-IB Interface Board is installed (see p. 58), that the separate computer is connected to the GP-IB Interface Board (see p. 59), and that the board's address selector DIP switches are set correctly (see p. 59).

After checking the above points, check that the AC power cord is connected to the CA-100's AC input terminal and to an AC wall outlet, and then set the POWER switch to **ON**. The sequence of displays shown at right will appear in the liquid crystal display.

Probe serial number



- If an external device is connected to the CA-100, set the POWER switch of the CA-100 to **ON** and then switch on the external device.

Default Settings

When the CA-100's POWER switch is first set to **ON**, the following settings will be automatically set.

Display mode	xyY
SYNC mode	EXT
Probe connector number	P1
Memory channel	00
Calibration data for user-selected reference	Minolta's standard calibration data
Standard color data	x=0.313, y=0.329, Y=40.0cd/m^2
ID label	Blank spaces
Analog display range value	10

The default settings of display mode, SYNC mode, probe connector number, and memory channel can be changed by the user if desired according to the following procedure.

1. Select the desired settings:
   a. Use **MODE** to select the desired display mode.
   b. Use **SYNC** to select the desired SYNC mode.
   c. Use **PROBE** to select the desired probe connector number.
   d. Use **MEMORY CH** ∧ or ∨ to select the desired memory channel.

2. While pressing **CURSOR** ▶, press **ENTER** to store the settings selected in step 1 as the default settings.

If calibration data for user-selected reference, standard color data, ID label, and/or analog display range value are changed by the user, the new data will remain in memory until changed again, even if the POWER switch is set to **OFF**.

- If remote is pressed, the CA-100 will be set to remote-control mode (REMOTE LED will become lit). In remote-control mode, the CA-100 will not respond to any key except **REMOTE**.

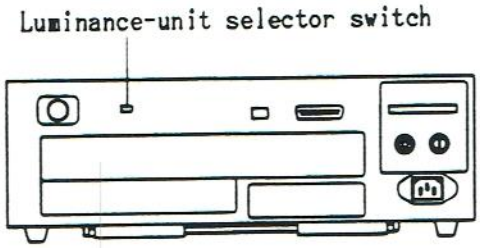
SWITCHING POWER OFF

When an external device has been connected to the CA-100, switch off the external device before setting the CA-100's POWER switch to **OFF**.

Selecting Luminance Unit

The CA-100 can measure luminance in terms of cd/m^2 or fL. At the time of shipment, the luminance unit is set as cd/m^2.

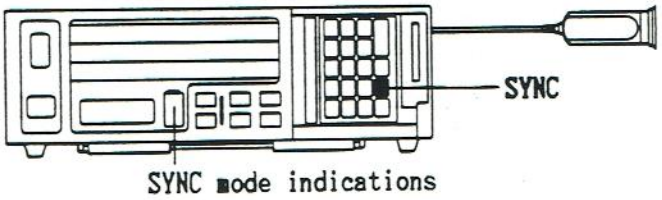
To select the desired luminance unit, set the luminance-unit selector switch on the back of the CA-100 to the position corresponding to the desired luminance unit.



Selecting SYNC mode

The CA-100 is equipped with four different SYNC (measurement synchronization) modes to allow measurements of a wide variety of CRTs with different vertical scanning frequencies. The four SYNC modes are:

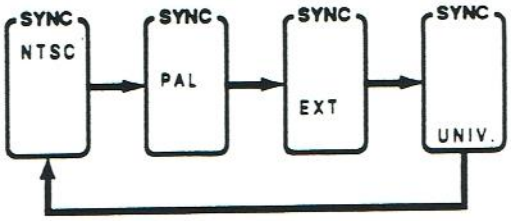
SYNC mode	Purpose	Measurement time (sampling rate)	Vertical scanning frequency	Input of CRT vertical synchronization signal to CA-100
NTSC	For measurements of NTSC-system televisions	33.3ms	60Hz	Not necessary
PAL	For measurements of PAL- or SECAM-system televisions	40.0ms	50Hz	Not necessary
EXT	For measurements utilizing an external synchronization signal.	Two times vertical scanning period	40 to 90Hz	Necessary
UNIV.	For measurements of CRTs for which vertical scanning rate is uncertain and from which synchronization signal cannot be obtained.	100ms	—	Not necessary



To select the SYNC mode for the CRT to be measured, follow the steps below.

1. Check that POWER switch is set to **ON**.

2. Press **SYNC** repeatedly to select the desired SYNC mode. The selected SYNC mode will change in the following order:



- If SYNC mode is set to EXT, an external synchronization signal must be input via the EXT (V. SYNC) terminal on the back of the CA-100.
- EXT is set as the default setting at the time of shipment.

The SYNC mode selected is one of the factors involved in determining the rate at which calculations and updating of displayed and output data can be performed. Other factors involved include:

- Luminance of the CRT being measured
- Display mode
- Baud rate (when outputting data via RS-232C terminal)
- Number of measuring probes being used (when using optional Multi-Probe Expansion Board CA-A13)

When measurements of a CRT having the maximum luminance of the Minolta standard are performed with the baud rate set to 9600 bps using one measuring probe, the rate for calculations and updating of displayed and output data is as follows:

Display mode / SYNC mode	xyY	TΔuvY
NTSC	10 times/s	8 times/s
PAL	8 times/s	7 times/s
EXT*	7 times/s	7 times/s
UNIV.	5 times/s	4 times/s

* With external synchronization signal frequency of 60Hz.

Selecting Display Mode

The CA-100 is equipped with two standard display modes and an analyzer display mode which can be added with an optional Analyzer Card.

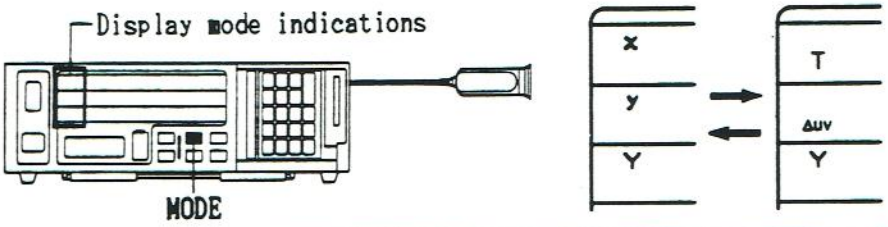
Display mode	Displayed/output values
xyY	Digital display shows chromaticity coordinates x and y, and luminance Y. Analog display shows Δx, Δy, and ΔY.
TΔuvY	Digital display shows correlated color temperature T, difference from blackbody locus Δuv, and luminance Y. Analog display shows Δx, Δy, and ΔY.
Analyzer (RBG)*	For green standard (available with optional Analyzer Card-G CA-A15 or Multi-Probe Analyzer Card-G CA-A18): Digital display shows measured RGB intensities as a percentage of the RGB intensities of the standard color (W). Analog display shows measured ratios R/G and B/G, and ΔG (difference between G intensity of standard color and measured G intensity).
	For red standard (available with optional Analyzer Card-R CA-A16 or Multi-Probe Analyzer Card-R CA-A19): Digital display shows measured RGB intensities as a percentage of the RGB intensities of the standard color (W). Analog display shows ΔR (difference between R intensity of standard color and measured R intensity) and measured ratios B/R and G/R.

* Analyzer (RBG) display mode is available only with Analyzer Card.

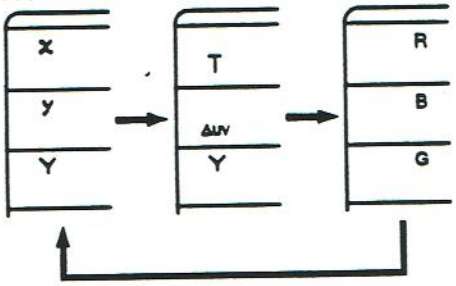
To select the desired display mode, follow the steps below.

1. Check that POWER switch is set to **ON**.

2. Press **MODE** repeatedly to select the desired display mode.
   If optional Analyzer Card is not used, the selected display mode will change in the following order:



If optional Analyzer Card is used, the selected display mode will change in the following order:



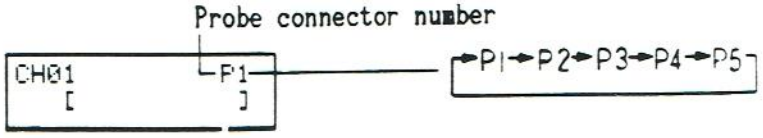
● xyY is set as the default setting at the time of shipment.

Selecting Probe Connector Number

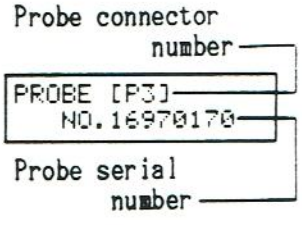
When the optional Multi-Probe Expansion Board CA-A13 is installed, up to five measuring probes can be connected to the CA-100. When more than one probe is connected, data measured by a probe can be displayed by selecting the number of the probe connector to which the probe is connected. The desired probe connector number can be selected by following the steps below.

1. Check that POWER switch is set to **ON**.

2. Press **PROBE** repeatedly to select the desired probe connector number. The selected probe connector number will change in the following order:

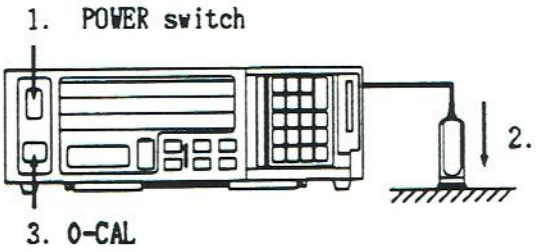


- Probe connector number P1 is set as the default setting at the time of shipment.
- If no probe is connected to a probe connector, that probe connector number cannot be selected. For example, if no probe is connected to probe connector number P4, the selected probe connector number would change from P3 to P5 if **PROBE** was pressed while the selected probe connector number was P3.
- The serial number of the probe connected to the selected probe connector will be shown in the liquid crystal display (as shown at right) while **PROBE** is held pressed. The data shown in the digital and analog displays will be the data measured by the probe connected to the selected probe connector. When **PROBE** is released, the liquid crystal display will return to the normal display showing selected memory channel, selected probe connector number, and ID label.



ZERO CALIBRATION

Zero calibration must be performed before any measurements can be taken after the POWER switch has been set to **ON**. Zero calibration determines the output of the measuring probe's receptor when no light is incident on the receptor, providing a reference point for measurements. To perform zero calibration, follow the steps below.



1. Check that POWER switch is set to **ON**.
2. Place receptor area of measuring probe face down on a flat surface so that no light reaches the receptor area.

> ● If optional Multi-Probe Expansion Board CA-A13 has been installed and more than one probe is connected to the CA-100, place receptor areas of all probes face down on a flat surface so that no light reaches the receptor area of any probe. If light reaches the receptor area of even one probe, zero calibration will not be correct.

3. After "PUSH 0-CAL KEY" appears in the liquid crystal display, press **0-CAL**. "ZERO CALIBRATION" will appear in the liquid crystal display while zero calibration is being performed, and then the liquid crystal display will return to the normal display showing selected memory channel, selected probe connector number, and ID label. Measurements will then start immediately.

Initial display after POWER switch set to **ON**	After approximately 5 seconds: Press **0-CAL**	Performing zero calibration	Zero calibration completed

- "E1" will appear in the liquid crystal display the first time the CA-100 is used after shipment because no standard color has been set.
- Zero calibration can be performed at any time, even if "PUSH 0-CAL KEY" is not shown in the liquid crystal display.

Note:
- If the luminance of the CRT to be measured is 1.00cd/m^2 (0.29 fL) or less, wait at least five minutes after setting POWER switch to **ON** before performing zero calibration. Also, when measuring CRTs of low luminance, zero calibration should be performed approximately once an hour to ensure accuracy.
- If the ambient temperature changes after zero calibration has been performed, perform zero calibration again.
- Do not press any key while zero calibration is being performed. If a key is pressed, the time required for zero calibration will become longer.

To check if zero calibration was performed correctly, place the receptor area of the probe face down on a flat surface so that no light reaches the receptor area.

If the display shown at right appears in the liquid crystal display, perform zero calibration again.

```
OFFSET ERROR
PUSH 0-CAL KEY
```

- Even when "OFFSET ERROR" appears in the liquid crystal display, if light reaches the receptor area of the measuring probe, measured values will appear in the digital and analog displays. However, these values will not be accurate.

If any other display is shown, zero calibration was performed correctly.

SUPPLEMENTARY OPERATIONS

Although it is possible to start taking measurements based on Minolta's standard calibration data immediately after performing zero calibration without performing any additional operations, to take full advantage of the capabilities of the CA-100, supplementary operations should be performed according to the specific purpose for which the CA-100 will be used. Supplementary operations include:

a. Setting/changing standard color data (p. 30)
Standard color data is necessary for using the analog displays. The standard color data which is set for one memory channel will be used for all measurements with that memory channel, regardless of the display mode selected.

- When taking measurements based on Minolta's calibration standard, if standard color data is desired it must be set separately.
- When calibration to a user-selected reference is performed, standard color data is automatically set to the calibration data for the user-selected reference. If desired, the standard color data can then be changed.
- When RGB emission characteristics for CRT phosphors are set, the standard color data is automatically set to the data for W. If desired, the standard color data can then be changed.

If calibration to a user-selected reference is performed or RGB emission characteristics of CRT phosphors are set, standard color data should be set after either of these operations has been performed.

b. Calibration to a user-selected reference (p. 33)
Calibration to a user-selected reference can be performed to:
- Adjust for slight variations between the spectral response of the measuring probe and the CIE 1931 color-matching functions;
- Standardize the response of several CA-100 units; or
- Standardize the response of several measuring probes (when using optional Multi-Probe Expansion Board CA-A13)

If calibration to a user-selected reference is desired, it should be performed before setting standard color (if performed).

- Standard color data is automatically set to the calibration data for user-selected reference when calibration to a user-selected reference is performed.

c. Setting RGB emission characteristics of CRT phosphors (p. 36)
(Possible only when using an optional Analyzer Card)
By setting the RGB emission characteristics of CRT phosphors, it is possible to directly measure and display the RGB (red, green, blue) beam intensities of the CRT being measured. Adjusting CRT white balance based on RGB beam intensities is much easier than adjustment based on xyY values.

- Standard color data is automatically set to the data for W when RGB emission characteristics of CRT phosphors are set.

d. Inputting ID label (p. 38)
An ID label can be input for each memory channel to identify different sets of stored calibration data or standard color data.

e. Setting analog display range (p. 39)
The analog display range can be set according to the acceptable adjustment accuracy.

Memory Channels

The CA-100 is equipped with 11 memory channels numbered from 00 through 10. In each channel, the following four types of information can be stored.

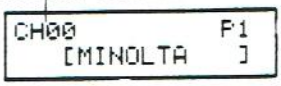
1. Calibration data for a user-selected reference*
2. RGB emission characteristics of CRT phosphors (possible only when using optional Analyzer Card)
3. Standard color data
4. ID label

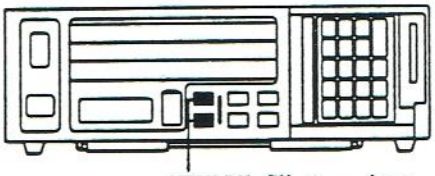
* Calibration data for a user-selected reference cannot be stored in memory channel 00, since memory channel 00 contains the calibration data for Minolta's standard. However, standard color data, ID label, and RGB emission characteristics for CRT phosphor (when using optional Analyzer Card) can still be stored.

SELECTING MEMORY CHANNEL

The desired memory channel can be selected by pressing **MEMORY CH** ∧ or ∨ repeatedly. The selected memory channel is shown in the upper left of the liquid crystal display.

Memory channel





MEMORY CH ∧ and ∨

WHEN USING OPTIONAL ACCESSORIES

Cards

When using an optional Memory Card or Analyzer Card, the number of memory channels available is increased from 11 to 100 (numbered 00 through 99).

Multi-Probe Expansion Board CA-A13

When optional Multi-Probe Expansion Board CA-A13 is installed, each probe connector has its own separate set of memory channels (11 standard; 100 if optional Multi-Probe Memory Card CA-A17, Multi-Probe Analyzer Card-G CA-A18, or Multi-Probe Analyzer Card-R CA-A19 is used) for storing calibration data for a user-selected reference, standard color data, or RGB emission characteristics of CRT phosphors. However, the ID label input for a memory channel of one probe connector will be applied to the same-numbered memory channel for all probe connectors.

Probe connector number		P1	P2	P3	P4	P5
Available memory channels for data	Standard	00 - 10	00 - 10	00 - 10	00 - 10	00 - 10
	When using optional cards for Multi-Probe Expansion Board	00 - 99	00 - 99	00 - 99	00 - 99	00 - 99
For ID label	Standard	00 - 10 (same for all probe connectors)				
	When using optional cards for Multi-Probe Expansion Board	00 - 99 (same for all probe connectors)				

Setting/Changing Standard Color Data

- It is not necessary to set standard color data if calibration to a user-selected reference has been performed (p. 33) or RGB emission characteristics of CRT phosphors have been set (p. 36) using the selected memory channel. During calibration to a user-selected reference, the standard color data is automatically set to the calibration data; during setting of RGB emission characteristics, standard color data is automatically set to the values for W (standard white). However, if it is desired to set the standard color data to other data than those automatically set, the following procedure can be performed.

Standard color data are necessary for using the analog display, which shows the percent difference between measured data and the standard color data or between two values of measured data. Standard color data is stored separately for each memory channel of each probe connector. Thus, if it is desired to use the same standard color data for several memory channels (or for the same memory channel of several probe connectors when using optional Multi-Probe Expansion Board CA-A13), the procedure for setting standard color data must be repeated for each memory channel (or probe connector).

Standard color data should be set according to either of the following procedures for the situations listed below:

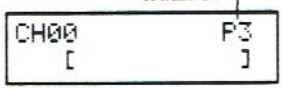
a. To set the standard color data for memory channel 00.
b. When measurements will be taken based on Minolta's calibration standard (when calibration to a user-selected reference has not been performed).
c. To set standard color data to values different from the calibration data set during calibration to a user-selected reference.
d. When using an optional Analyzer Card, to set the standard color data to values different from those set for W (standard white) during setting of RGB emission characteristics of CRT phosphors.

SETTING/CHANGING PROCEDURE

Standard color data can be set or changed by measurement or (for memory channel 00 only) by inputting numerical xyY values using the number keys.

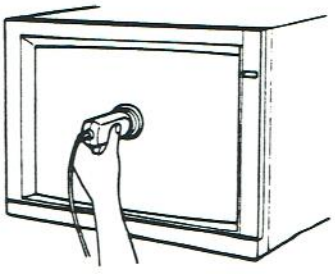
By Measurement

- When using optional Multi-Probe Expansion Board CA-A13, press **PROBE** repeatedly to select the desired probe connector number.



1. Press **MEMORY CH** ∧or∨ repeatedly to select the memory channel in which the standard color data will be stored.

2. Place the receptor area of the measuring probe flat against the surface of the CRT on which the desired standard color has been generated.



3. While holding the measuring probe against the surface of the CRT, press **HOLD**. The measured value will be held in the digital display.

4. Press **ENTER**. The data measured and held in step 3 will be stored as the standard color data for the selected memory channel.

5. Press **HOLD** again to cancel display hold and start measurements.

- The standard color data stored in the selected memory channel can be checked at any time by pressing **M R**.
- At the time of shipment, the standard color data for all memory channels is set to x = 0.313, y = 0.329, and Y = 40.0 cd/m^2.

Note:

- The standard color data which are set will be used for all display modes: xyY, TΔuvY, and analyzer (RBG).
- If the CRT being measured has a luminance of 1.00cd/m^2 or less, or if the ambient temperature has changed since zero calibration was performed, perform zero calibration before setting standard color data.
- The static electricity of the surface of the CRT should be eliminated as much as possible before setting standard color data.
- Be sure that the probe is held flat against the CRT surface. If the probe is at an angle to the surface or is moved, standard color will not be set accurately.
- If "OVER" is shown in the liquid crystal display, it might not be possible to set the generated color as the standard color.
- Do not subject the measuring probe to shock or strong force. Do not pull on or sharply bend the connecting cord, or subject it to strong force.

By Inputting Numerical Values

- Only the standard color for memory channel 00 can be set by inputting numerical values.

- When using optional Multi-Probe Expansion Board CA-A13, press **PROBE** repeatedly to select the desired probe connector number.

Probe connector number

```
CH01          P1
  [            ]
```

- When using an optional Analyzer Card, press **MODE** repeatedly to select either xyY or TΔuvY display mode.

1. Press **MEMORY CH** ∧or∨ repeatedly to select memory channel 00.

Memory channel

```
CH01          P1
  [            ]
```

2. Press **CAL**. The presently stored standard color data will appear in the liquid crystal display and the cursor will appear under the first digit of the first value of the displayed data. Calibration LED will light.

```
CH00 x    y    Y
P1 400 400 15.0
```

3. Use number keys (0 through 9) to set the first value of the standard color data. Cursor will automatically move to the next digit each time a number key is pressed.

```
CH00 x    y    Y
P1 313 400 15.0
```

4. Press **CURSOR** ▶ to move to the next value.

```
CH00 x    y    Y
P1 313 400 15.0
```

5. Use number keys (0 through 9) to set the next value of the standard color data. Cursor will automatically move to the next digit each time a number key is pressed.

```
CH00 x    y    Y
P1 313 329 15.0
```

6. Press **CURSOR** ▶ to move to the last value.

```
CH00 x    y    Y
P1 313 329 15.0
```

7. Use number keys (0 through 9 and .) to set the last value of the standard color data. Cursor will automatically move to the next digit each time a number key is pressed.

```
CH00 x    y    Y
P1 313 329 22.5
```

8. Press **ENTER**. The data set in steps 3 through 7 will be stored as the standard color data for memory channel 00. The calibration LED will become not lit.

- To interrupt the setting procedure, press **CAL** again before pressing **ENTER**. The calibration lamp will become not lit.
- The standard color data stored in the selected memory channel can be checked at any time by pressing **M R**.
- At the time of shipment, the standard color data for all memory channels is set to x = 0.313, y = 0.329, and Y = 40.0 cd/m^2.

Note:

- The standard color data which are set will be used for all display modes: xyY, TΔuvY, and analyzer (RBG).
- If "OVER" is shown in the liquid crystal display, the CA-100 might not respond when **CAL** is pressed.
- Do not press **MODE**, **M R**, **REMOTE**, **MEMORY CH** ∧or∨ , **0-CAL**, **RANGE**, **ID**, or **PROBE** while in the middle of the procedure for setting standard color data. Pressing any of these keys will result in the setting mode being canceled and the operation corresponding to the key being performed.

Calibration to a User-Selected Reference

Calibration to a user-selected reference is performed by measuring a reference CRT and inputting its calibration data to determine the correction factor required to meet a user's specific requirements. Subsequent measurements are then calculated using this correction factor. Calibration to a user-selected reference can be performed separately for each memory channel (except memory channel 00) of each probe connector number.

At the time of shipment, the calibration data stored in all memory channels is the calibration data for Minolta's standard. Calibration to a user-selected reference can be performed to:

a. Adjust for slight variations between the spectral response of the measuring probe and the CIE 1931 color-matching functions;
b. Standardize the response of several CA-100 units; or
c. Standardize the response of several measuring probes (when using optional Multi-Probe Expansion Board CA-A13)

- When calibration to a user-selected reference is performed, the calibration data is also automatically stored as the standard color data for the selected memory channel. If it is desired to use different standard color data, the standard color data can be changed according to the procedure on p. 30 after calibration to a user-selected reference has been performed.

To standardize the response of several CA-100 units or to standardize the response of several probes when using the optional Multi-Probe Expansion Board CA-A13, follow either of the procedures below.

a. When the values of the user-selected reference color displayed on the CRT to be used for calibration are known, these values should be used as the calibration data for all CA-100 units (or measuring probes) when performing calibration according to CALIBRATION PROCEDURE on p. 34.
b. If the values of the user-selected reference color displayed on the CRT to be used for calibration are not known:
   1. Select one CA-100 (or measuring probe) as the master unit (or master measuring probe).
   2. Set display mode to xyY and place the master unit's measuring probe (or the master measuring probe) against the surface of the CRT displaying the reference color.
   3. With the measuring probe firmly against the CRT surface, press HOLD.
   4. Use the values measured in step 3 as the calibration values for the reference color displayed on the CRT to calibrate all other CA-100 units (or measuring probes) according to CALIBRATION PROCEDURE on p. 34.

CALIBRATION PROCEDURE

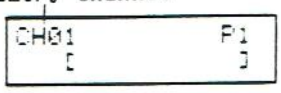
- Memory channel 00 cannot be calibrated to a user-selected reference.
- Calibration to a user-selected reference should be performed using a CRT of the same type as the CRTs which will be measured. Differences in phosphors, light-distribution characteristics, glass thickness, etc. between CRT types may result in measurement differences.
- If calibration to a user surface is performed for a memory channel in which standard color data are already stored, the previously stored standard color data will be erased when calibration is completed.

- When using optional Multi-Probe Expansion Board CA-A13, press **PROBE** repeatedly to select the desired probe connector number. The memory channels for each probe connector are separate; for a selected memory channel, each probe connector must thus be calibrated separately to the same reference, or can be calibrated to different references if desired.

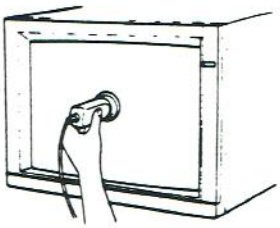
1. Press **MODE** repeatedly to select xyY display mode.

2. Press **MEMORY CH** ∧ or ∨ repeatedly to select the memory channel to be calibrated.

Memory channel



3. Place the receptor area of the measuring probe flat against the surface of the CRT on which reference color has been generated.



4. Press **HOLD**. The latest measured value will be held in the digital display.

5. Press **CAL**. The previously set calibration data will appear in the liquid crystal display as shown at right and the calibration LED will light. The cursor will appear under the first digit of the first value in the liquid crystal display.

6. Use number keys (0 through 9) to set the first value of the calibration data for the reference color shown on the CRT. Cursor will automatically move to the next digit each time a number key is pressed.

7. Press **CURSOR** ▶ to move to the next value.

8. Use number keys (0 through 9) to set the next value of the calibration data. Cursor will automatically move to the next digit each time a number key is pressed.

9. Press **CURSOR** ▶ to move to the last value.

10. Use number keys (0 through 9 and .) to set the last value of the calibration data. Cursor will automatically move to the next digit each time a number key is pressed.

11. Press **ENTER**. The calibration data will be stored in the selected memory channel and the data will also be automatically stored as the standard color data for that memory channel.

12. Press **HOLD** again to cancel display hold and start measurements.

- To interrupt calibration procedure, press **CAL** again before pressing **ENTER**. The calibration lamp will become not lit.
- If the standard color data of the selected memory channel has not been changed since calibration to a user-selected reference was performed, the stored standard color data (which will be the same as the calibration data) can be checked by pressing **M R**. If the standard color data was changed after calibration to a user-selected reference was performed, the standard color data will be different from the calibration data.
- Calibration can also be performed without using display hold (without pressing **HOLD** as in step 4). In this case, the data displayed when **ENTER** is pressed in step 11 will be stored as the calibration data.

Note:

- The calibration data is also stored as the standard color data, which will be used for all display modes: xyY, TΔuvY, and analyzer (RBG).
- If the CRT being measured has a luminance of 1.00cd/m^2 or less, or if the ambient temperature has changed since zero calibration was performed, perform zero calibration before performing calibration to a user-selected reference.
- The static electricity of the surface of the CRT should be eliminated as much as possible before calibration or measurement.
- Be sure that the probe is held flat against the CRT surface. If the probe is at an angle to the surface or is moved, calibration will not be accurate.
- If "OVER" is shown in the liquid crystal display, the CA-100 may not respond when **CAL** is pressed.
- Do not press **MODE**, **M R**, **REMOTE**, **MEMORY CH** $\wedge$or$\vee$, **0-CAL**, **RANGE**, **ID**, or **PROBE** while in the middle of the calibration procedure. Pressing any of these keys will result in calibration mode being canceled and the operation corresponding to the key being performed.
- Do not subject the measuring probe to shock or strong force. Do not pull on or sharply bend the connecting cord, or subject it to strong force.

Setting RGB Emission Characteristics of CRT Phosphors

In order to use analyzer (RBG) display mode (available only with an optional Analyzer Card), it is necessary to input the RGB emission characteristics of the CRT phosphors.

- The RGB emission characteristics of the phosphors should be set using a CRT of the same type as the CRTs which will be measured. Differences in phosphors, light-distribution characteristics, glass thickness, etc. between CRT types may result in measurement differences.
- If RGB emission characteristics are set for a memory channel in which standard color data are already stored, the previously stored standard color data will be erased when the emission characteristics are set. Standard color data set for the selected memory channel are used for all display modes: xyY, T uvY, and analyzer (RBG).

SETTING PROCEDURE

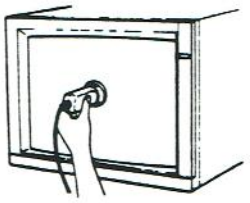
- Before setting RGB emission characteristics of the CRT phosphors, insert the optional Analyzer Card in the memory card slot, set POWER switch to ON, and perform zero calibration.
- When using optional Multi-Probe Expansion Board CA-A13, press **PROBE** repeatedly to select the desired probe connector number.

1. Press **MODE** repeatedly to select analyzer (RBG) display mode.
2. Press **MEMORY CH** ∧or∨ repeatedly to select the memory channel for which RGB emission characteristics will be set.

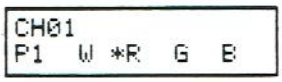
Memory channel

3. Press **CAL.** The display shown at right will appear in the liquid crystal display. Calibration LED and W, R, G, and B LEDs will light.

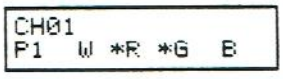
4. Set emission characteristics of red phosphor:
   a. Set CRT so that pure red is generated.
   b. Place receptor area of measuring probe flat against the surface of the CRT.



   c. Press **4** next to the R LED. "*" will appear before "R" in the liquid crystal display.



5. Set emission characteristics of green phosphor:
   a. Set CRT so that pure green is generated.
   b. Place receptor area of measuring probe flat against the surface of the CRT.
   c. Press **1** next to the G LED. "*" will appear before "G" in the liquid crystal display.



6. Set emission characteristics of blue phosphor:
   a. Set CRT so that pure blue is generated.
   b. Place receptor area of measuring probe flat against the surface of the CRT.
   c. Press 0 next to the B LED. "*" will appear before "B" in the liquid crystal display.

```
CH01
F1   W *R *G *B
```

7. Set standard white values:
   a. Set CRT so that standard white is generated.
   b. Place receptor area of measuring probe flat against the surface of the CRT.
   c. Press 7 next to the W LED. "*" will appear before "W" in the liquid crystal display.

```
CH01
F1 *W *R *G *B
```

8. Press **ENTER**. The values for R, G, B, and W will be stored as the emission characteristics of the CRT phosphors, and the W, R, G, B, and calibration LEDs will become not lit. The values for white will also be stored as the standard color data.

- Setting the R, G, B, and W values (steps 4, 5, 6, and 7) can be done in any order.
- Setting the R, G, B, or W value can be repeated if a mistake is made by generating the appropriate color on the CRT and pressing the appropriate key again before pressing **ENTER** (before step 8).
- To interrupt the procedure for setting RGB emission characteristics of CRT phosphors, press **CAL** again before pressing **ENTER** (before step 8).
- If **M R** is pressed, "100" will be displayed as the values for the standard color.

Note:
- The data for white is stored as the standard color data, which will be used for all display modes: xyY, TΔuvY, and analyzer (RBG).
- At the time of shipment, no emission characteristics of CRT phosphors are stored in memory. If analyzer (RBG) display mode is set before RGB emission characteristics are input, operation will not be correct.
- If the CRT being measured has a luminance of 1.00cd/m^2 or less, or if the ambient temperature has changed since zero calibration was performed, perform zero calibration before setting emission characteristics of CRT phosphors.
- The static electricity of the surface of the CRT should be eliminated as much as possible before setting emission characteristics of CRT phosphors.
- Be sure that the probe is held flat against the CRT surface. If the probe is at an angle to the surface or is moved, RGB emission characteristics of CRT phosphors will not be set accurately.
- If "OVER" is shown in the liquid crystal display, the CA-100 may not respond when **CAL** is pressed.
- Do not press **MODE**, **M R**, **MEMORY CH** $\wedge$ or $\vee$, **0-CAL**, **RANGE**, **ID**, or **PROBE** while in the middle of the procedure for setting emission characteristics of CRT phosphors. Pressing any of these keys will result in the setting mode being canceled and the operation corresponding to the key being performed.
- Do not subject the measuring probe to shock or strong force. Do not pull on or sharply bend the connecting cord, or subject it to strong force.

Inputting ID Label

An ID label can be input by the user to enable easy identification of memory channels. The ID label might consist of, for example, a code or abbreviation specifying the type of CRT used to calibrate the memory channel and/or set the target color data. The ID label is shown (along with the selected memory channel and probe connector number) in the liquid crystal display at the time of measurement. The ID label can be up to 10 characters long; available characters include numbers ("0" through "9"), letters ("A" through "Z"), period (".") , hyphen ("-"), and a blank space(" ").

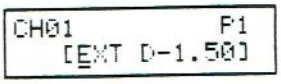
- When using Multi-Probe Expansion Board CA-A13, the ID label input for a memory channel will be applied to the same memory channel of all probe connector numbers. It is not possible to set different ID labels for the same memory channel of different probe connectors.

1. Press **MEMORY CH** ∧or∨ repeatedly to select the memory channel for which ID label will be input.

Memory channel

2. Press **ID**. The previously set ID label will appear in the liquid crystal display, with a cursor under the first character position of the ID label.

3. Use number keys (0 through 9 and .) and **ALPHA** ▲or▼ to select the desired character.



- **ALPHA** ▲ changes displayed character in alphabetical order; hyphen ("-") and space (" ") appear between "Z" and "A":
  A → B → C → ... Y → Z → - → (space) → A →
  ALPHA ▼ changes displayed character in reverse alphabetical order:
  A → (space) → - → Z → Y → ... C → B → A
  Displayed character will change to next character each time **ALPHA**▲or▼ is pressed; displayed character will change continuously if **ALPHA** ▲or▼ is held pressed.

- Cursor will automatically move right when a character is input using a number key (0 through 9 or .); cursor will not move right automatically when **ALPHA** ▲or▼ is used.

4. If necessary, press **CURSOR** ▶ to move to the next character position. Cursor will move right each time **CURSOR** ▶ is pressed; cursor will move right continuously if **CURSOR** ▶ is held pressed.

5. Repeat steps 3 and 4 to input the remaining characters of the desired ID label.

6. Press **ENTER**. The ID label will be stored in the selected memory channel. The ID label will remain in memory until changed by the user, even if the CA-100 is switched off.

- To interrupt the input of ID label, press **ID** again before pressing **ENTER** (before step 6).

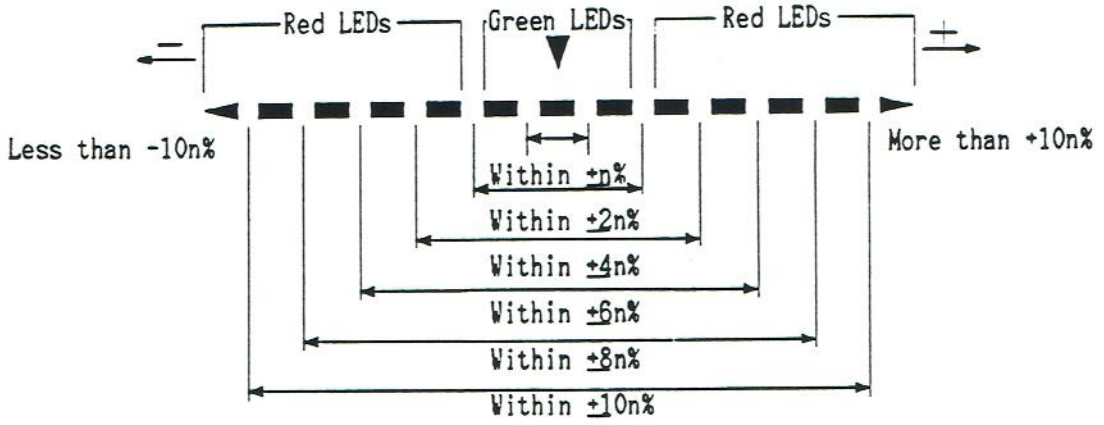
Note:
- If "OVER" is shown in the liquid crystal display, the CA-100 may not respond when ID is pressed.
- Do not press **MODE**, **M R**, **REMOTE**, **MEMORY CH** ∧or∨ , **0-CAL**, **RANGE**, **CAL**, or **PROBE** while in the middle of the procedure for inputting ID label. Pressing any of these keys will result in the ID input mode being canceled and the operation corresponding to the key being performed.

Setting Analog Display Range

The analog display shows the percent difference between the measured data and the standard color data. The range for one LED (of the three center green LEDs) can be set by the user according to the procedure below.

- When using an optional Analyzer Card, the range set for xyY and TΔuvY display modes is separate from the range set for analyzer (RBG) display mode.
- When using optional Analyzer Card-G CA-A15 or Multi-Probe Analyzer Card-G CA-A18 with display mode set to analyzer (RBG), the analog display ranges for R/G, B/G, and ΔG can be set separately.
- When using optional Analyzer Card-R CA-A16 or Multi-Probe Analyzer Card-R CA-A19 with display mode set to analyzer (RBG), the analog display ranges for ΔR, B/R, and G/R can be set separately.

The analog display range can be set from 0.1 to 99% per green LED: 0.1 to 9.9% in 0.1% increments, 10 to 99% in 1% increments. The per-LED display range for the red LEDs is twice that of the green LEDs. Thus, for an analog display range of n, the display would be read as shown below.



FORMULAS

The formulas for determining the values indicated on the analog displays are as follows:

Display mode: xyY or TΔuvY

$$\Delta x = \left(\frac{x - x_t}{x_t}\right) \times 100\ (\%)$$

$$\Delta y = \left(\frac{y - y_t}{y_t}\right) \times 100(\%)$$

$$\Delta Y = \left(\frac{Y - Y_t}{Y_t}\right) \times 100\ (\%)$$

x, y, Y: Measured values
x_t, y_t, Y_t: Standard color data

When using optional Analyzer Card-G CA-A15 or Multi-Probe Analyzer Card-G CA-A18 with analyzer (RBG) display mode:

$$R/G = \left(\frac{R - G}{G}\right) \times 100\ (\%)$$

$$B/G = \left(\frac{B - G}{G}\right) \times 100\ (\%)$$

$$\Delta G = \left(\frac{G - G_t}{G_t}\right) \times 100\ (\%) = G - 100\ (\%)$$

R, G, B: Measured values
G_t: Standard color value adjusted to provide a G beam intensity of 100 for the standard color

When using optional Analyzer Card-R CA-A16 or Multi-Probe Analyzer Card-R CA-A19 with analyzer (RBG) display mode:

$$\Delta R = \left(\frac{R - R_t}{R_t}\right) \times 100\ (\%) = R - 100\ (\%)$$

$$B/R = \left(\frac{B - R}{R}\right) \times 100\ (\%)$$

$$G/R = \left(\frac{G - R}{R}\right) \times 100\ (\%)$$

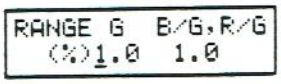
R, G, B: Measured values
R_t: Standard color value adjusted to provide an R beam intensity of 100 for the standard color

SETTING PROCEDURE

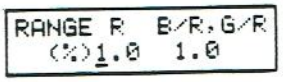
- When using an optional Analyzer Card, press **MODE** repeatedly to select the desired display mode.

1. Press **RANGE**. The presently set analog display range will appear in the LCD panel, with the cursor under the first digit of the first value.

When using an optional Analyzer Card (G standard):



When using an optional Analyzer Card (R standard):



2. Use number keys (**0** through **9** and **.**) to input the first value of the analog display range. Cursor will automatically move to the next digit each time a number key is pressed.

3. Press **CURSOR** ▶ to move to the next value.

4. Use number keys (**0** through **9** and **.**) to input the second value of the analog display range. Cursor will automatically move to the next digit each time a number key is pressed.

5. Press **ENTER**. The values input in steps 2 through 4 will be stored as the analog display range for the selected display mode.

- To interrupt the procedure for setting the analog display range, press **RANGE** again before pressing **ENTER** (before step 5).
- The values of the analog display range will be applied to all memory channels (and probe connector numbers if using optional Multi-Probe Expansion Board CA-A13).
- At the time of shipment, the analog display range is set to 10%.
- The values of the analog display range will remain in memory even if the POWER switch is set to **OFF**.

Note:
- If "OVER" is shown in the liquid crystal display, the CA-100 may not respond when **RANGE** is pressed.
- Do not press **MODE**, **M R**, **REMOTE**, **MEMORY CH** ∧or∨ , **0-CAL**, **ID**, **CAL**, or **PROBE** while in the middle of the procedure for setting analog display range. Pressing any of these keys will result in the setting mode being canceled and the operation corresponding to the key being performed.

RELATION BETWEEN DIGITAL AND ANALOG DISPLAYS

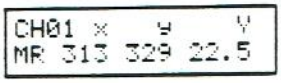
The digital display of the CA-100 shows the three most significant figures of the measured value. The fourth significant figure of the measured value is rounded off.

Depending on the analog display range which is set, the calculations performed for the analog display may use more than four significant figures. Thus, if the analog display range is set to a small value, the accuracy of the analog display may be higher than that of the digital display. In this case, the values shown by the two displays may be slightly different.

Checking Stored Data

STANDARD COLOR DATA

To check the standard color data stored in the selected memory channel, press **M R**. The standard color data will appear in the liquid crystal display as shown at right.



CALIBRATION DATA

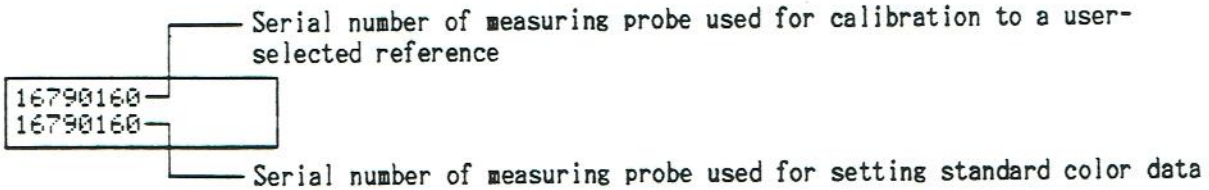
If the standard color data for the selected memory channel was not changed after calibration to a user-selected reference was performed, the calibration data can be checked according to the procedure above for checking standard color data, since the calibration data will be the same as the standard color data.

However, if the standard color data was changed after calibration to a user-selected reference was performed, it is not possible to check the calibration data.

MEASURING PROBE SERIAL NUMBER

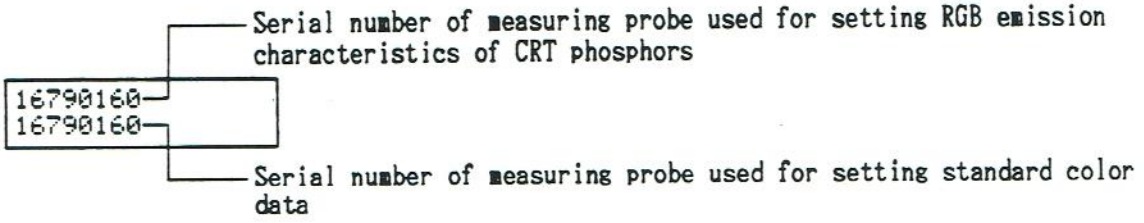
Serial Number of Measuring Probes Used For Setting Data

The serial number of the measuring probe used for performing calibration to a user-selected reference and the serial number of the measuring probe used for setting standard color data can be checked by pressing **PROBE** while **M R** is held pressed. The serial numbers of the measuring probes will appear in the liquid crystal display as shown below.


Serial number of measuring probe used for calibration to a user-selected reference
16790160
16790160
Serial number of measuring probe used for setting standard color data

- At the time of shipment, the stored measuring probe serial numbers are all set to "00000000".

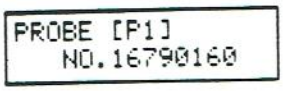
When using an optional Analyzer Card:
The serial number of the measuring probe used for setting RGB emission characteristics of CRT phosphors and the serial number of the measuring probe used for setting standard color data can be checked by pressing **PROBE** while **M R** is held pressed. The serial numbers of the measuring probes will appear in the liquid crystal display as shown below.


Serial number of measuring probe used for setting RGB emission characteristics of CRT phosphors
16790160
16790160
Serial number of measuring probe used for setting standard color data

- At the time of shipment, the stored measuring probe serial numbers are all set to "00000000".

Serial Number of Measuring Probe Presently Being Used

To check the serial number of the measuring probe presently being used, press **PROBE**. While **PROBE** is held pressed, the serial number of the measuring probe presently being used will be shown in the liquid crystal display.



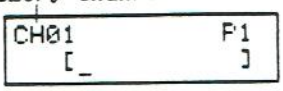
- When using Multi-Probe Expansion Board CA-A13 with more than one measuring probe connected to the CA-100, pressing **PROBE** will select the next probe connector number. If **PROBE** is held pressed, the serial number of the measuring probe connected to the selected probe connector number will be shown in the display.

TAKING MEASUREMENTS

After all preparations have been completed and desired supplementary operations have been performed, measurements can be taken by following the steps below.

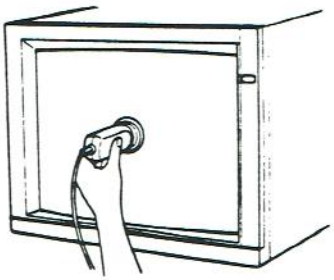
1. Press **MEMORY CH** ∧or∨ to select the desired memory channel. Supplementary operations (calibration to a user-selected reference, setting of RGB emission characteristics for CRT phosphors, and setting/changing standard color data) should have already been performed for the selected memory channel.

Memory channel



- If measurements will be taken based on Minolta's calibration standard and the analog displays will not be used, it is not necessary to select a memory channel for which supplementary operations have been performed.

2. Place the receptor area of the measuring probe flat against the surface of the CRT to be measured. Measurements will be started immediately and the measured data will be shown in the digital and analog displays according to the selected display mode.

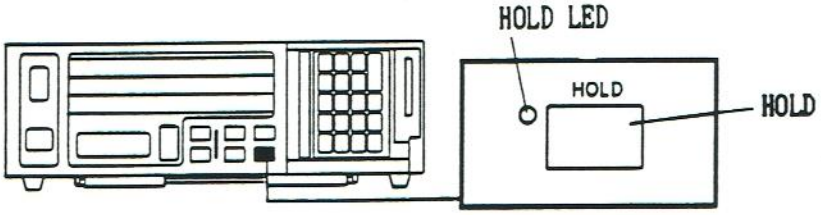


When using optional Multi-Probe Expansion Board CA-A13:
Measurements are taken simultaneously by all connected measuring probes. The displayed data is the measured data for only the selected probe connector number, which is shown in the liquid crystal display. To change the selected probe connector number, press **PROBE**.

Note:
- The static electricity of the surface of the CRT should be eliminated as much as possible before calibration or measurement.
- If the CRT being measured has a luminance of 1.00cd/m^2 or less, or if the ambient temperature has changed since zero calibration was performed, perform zero calibration before taking measurements.
- If the CRT being measured has a luminance of 1.00cd/m^2 or less and will be measured over a long period of time, zero calibration should be performed approximately once an hour.
- Be sure that the measuring probe is held flat against the CRT surface. If the measuring probe is at an angle to the surface or is moved, measurements will not be accurate.
- Do not subject the measuring probe to shock or strong force. Do not pull on or sharply bend the connecting cord, or subject it to strong force.

Display Hold

To set display hold and hold the presently displayed data in the digital and analog displays, press **HOLD**. The displays will be held and the HOLD LED will light.



- If any of the measurement conditions (display mode, etc., with the exception of SYNC mode) are changed while display is being held, the values corresponding to the new measurement conditions will be calculated and displayed.

To cancel display hold, press **HOLD** again. Display hold will be canceled, the HOLD LED will become not lit, and the displays will show the latest measurement data.

Note:
- Display hold cannot be set in the following situations:
  a. After **0-CAL** has been pressed, but before measured data appears in the displays.
  b. While the error message "NO SYNC. SIGNAL" is shown in the liquid crystal display.
- If **0-CAL** is pressed while display hold is set, display hold will be canceled.

Displayed Data

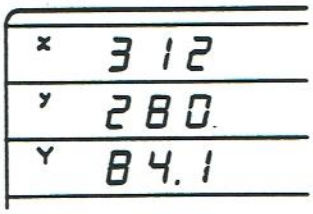
DIGITAL DISPLAY

The CA-100's digital display shows the numerical measured data. Displayed values are updated once every three measurement cycles.

Displayed values: For xyY display mode: x, y, and Y
For TΔuvY display mode: T, Δuv, and Y

- The displayed values for x and y or for Δuv are 1000 times the actual value.
- The displayed value for T consists of the three most significant figures of the measured value.

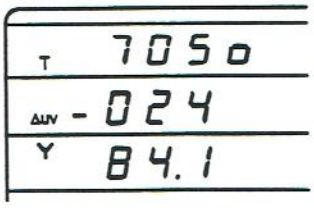
Display range: Y: 0.01 to 999cd/m^2 (0.01 to 292 fL)
0.01 to 9.99 in increments of 0.01
10.0 to 99.9 in increments of 0.1
100 to 999 in increments of 1
* For Y values of less than 0.20cd/m^2 (0.06 fL), the digital display will be blinking.



xyY display mode

T: 2300 to 20000K

Δuv: |Δuv| < 0.1



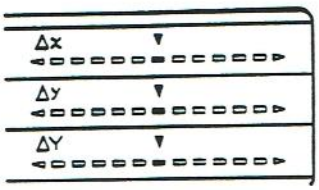
TΔuvY display mode

ANALOG DISPLAY

The analog displays show the percent difference between the measured data and the standard color data.

Displayed values: Δx, Δy, ΔY

Display range depends on the setting of analog display range (see p. 39).



WHEN USING AN OPTIONAL ANALYZER CARD

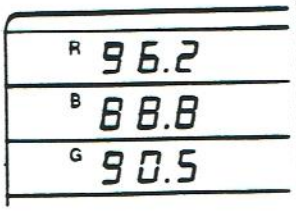
When using an optional Analyzer Card with analyzer (RBG) display mode, displays function as follows:

Digital Display

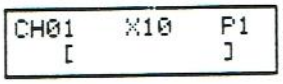
Displayed values: R, B, and G

- R, B, and G express the presently measured beam intensities as a percentage of the beam intensities of the standard color (W) normalized to 100. If the measured beam intensities are equal to those of W, "100" would be displayed.

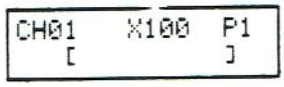
Display range: 0.1 to 99900%
0.1 to 99.9% in increments of 0.1
100 to 999 in increments of 1
1000 to 9990% in increments of 10*
10000 to 99900% in increments of 100**



* For measured data of 1000 to 9990%, "X10" will be shown in the liquid crystal display and the true measured data can be obtained by multiplying the three-digit values shown in the digital display by 10.



** For measured data of 10000 to 99900%, "X100" will be shown in the liquid crystal display and the true measured data can be obtained by multiplying the three-digit values shown in the digital display by 100.

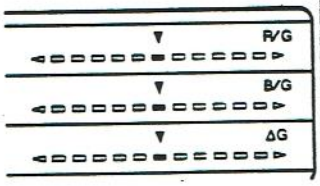


Analog Display

Displayed values:

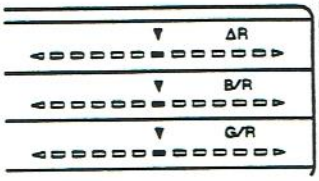
For Analyzer Card-G CA-A15 or Multi-Probe Analyzer Card-G CA-A18:

R/G: Ratio of measured R value to measured G value
B/G: Ratio of measured B value to measured G value
ΔG: Difference between measured G value and G value of standard color data



For Analyzer Card-R CA-A16 or Multi-Probe Analyzer Card-R CA-A19:

ΔR: Difference between measured R value and R value of standard color data
G/R: Ratio of measured G value to measured R value
B/R: Ratio of measured B value to measured R value



Display range depends on the setting of analog display range (see p. 39).

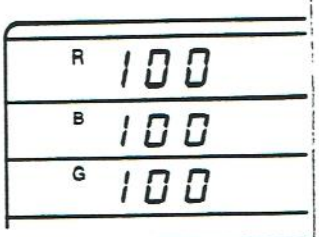
ADJUSTING WHITE BALANCE USING ANALYZER (RBG) DISPLAY MODE

- Analyzer (RBG) display mode is available only when using an optional Analyzer Card.

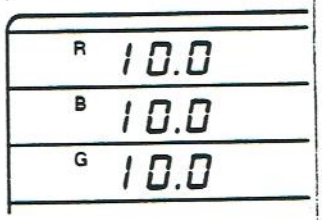
White-balance adjustment is most easily done using analyzer (RBG) display mode. In analyzer (RBG) display mode, the measured R, B, and G beam intensities are displayed individually as percentages of the RGB emission characteristics for CRT phosphors which were previously stored in memory. Therefore, when adjusting the R beam intensity, only the measured R value changes; the B and G values do not change. Individual display of the R, B, and G beam intensities makes it easy to match the standard color (W).

Before white balance can be performed in analyzer (RBG) display mode, the RGB emission characteristics for the CRT phosphors and the standard color (W) must be input (see p. 36). The standard color (W) which is input should be the white which is desired as the final result of white-balance adjustment.

In analyzer (RBG) display mode, when the R, B, and G values shown in the digital display are all 100, the white displayed by the CRT matches the standard color (W) stored in the selected memory channel (the xyY values are the same). Accordingly, only the center green LEDs of the analog display will be lit.



If the values of R, B, and G shown in the digital display are not 100 but are all the same, the luminance Y of the measured CRT is different from that of the standard color (W) stored in memory but the chromaticity coordinates x and y are the same. Thus, it is only necessary to adjust the luminance of the CRT. In this case, since the x and y coordinates are correct, only the center green LEDs of the R/G and B/G lines (for G-standard Analyzer Cards) or of the B/R and G/R lines (for R-standard Analyzer Cards) of the analog display will be lit.



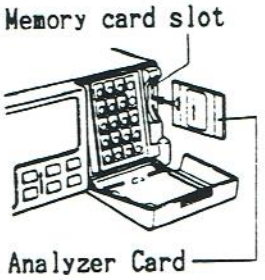
Four different optional Analyzer Cards are available for the CA-100, for adjustment of different types of CRTs:

- For adjustment of CRTs for which the G beam intensity cannot be independently adjusted, Analyzer Card-G CA-A15 (when using a single measuring probe) or Multi-Probe Analyzer Card-G Ca-A18 (when using the optional Multi-Probe Expansion Board CA-A13 and more than one measuring probe) should be used.
- For adjustment of CRTs for which the R beam intensity cannot be independently adjusted, Analyzer Card-R CA-A16 (when using a single measuring probe) or Multi-Probe Analyzer Card-R CA-A19 (when using the optional Multi-Probe Expansion Board CA-A13 and more than one measuring probe) should be used.
- For adjustment of CRTs for which all three beam intensities (R, G, and B) can be independently adjusted, either Analyzer Card-G CA-A15 or Analyzer Card-R CA-A16 can be used with a single measuring probe; either Multi-Probe Analyzer Card-G CA-A18 or Multi-Probe Analyzer Card-R CA-A19 can be used with the optional Multi-Probe Expansion Board CA-A13 and more than one measuring probe.

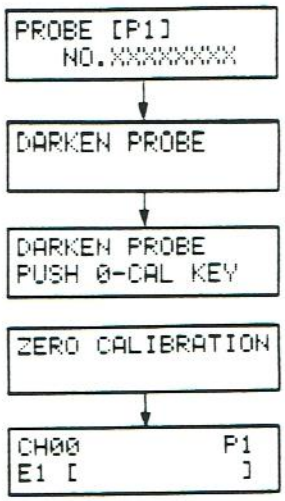
Procedure

1. Set POWER switch to **OFF**.

2. Position the Analyzer Card as shown at right and insert the card fully into the memory card slot.



3. Set POWER switch to **ON**.



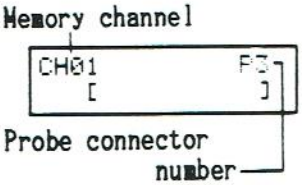
4. Place receptor area of measuring probe face down on a flat surface so that no light reaches the receptor area and press **0-CAL** to perform zero calibration.

- If optional Multi-Probe Expansion Board CA-A13 has been installed and more than one probe is connected to the CA-100, place receptor areas of all probes face down on a flat surface so that no light reaches the receptor area of any probe before pressing **0-CAL**.

5. Press **MODE** repeatedly to select analyzer (RBG) display mode.

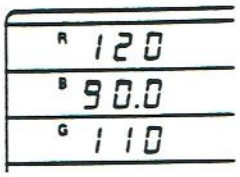
6. Press **MEMORY CH** ∧or∨ to select the memory channel containing the desired RGB emission characteristics of CRT phosphors.

7. If optional Multi-Probe Expansion Board CA-A13 has been installed and more than one measuring probe is being used, press **PROBE** repeatedly to select the desired probe connector number.



8. Place the receptor area of the measuring probe flat against the surface of the CRT to be adjusted. Measurements will be started immediately and the measured data will be shown in the digital and analog displays.

9. Adjust white balance according to the procedure below.
Normally, white balance is adjusted by adjusting the cutoff and drive voltages. However, in the procedure below, the CRT is adjusted so that the white generated on the CRT matches the standard color (W) stored in memory.



In this example, the initial measured values are shown at right. The R beam intensity is 20% too high, B beam intensity is 10% too low, and the G beam intensity is 10% too high.

- Display examples are intended as only examples and are not displays obtained through actual measurements.

If using a G-standard analyzer card (Analyzer Card-G CA-A15 or Multi-Probe Analyzer Card-G CA-A18):

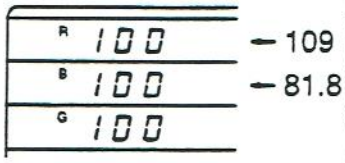
a. Adjust luminance (or G beam intensity) first so that the value shown in the digital display for G becomes 100.

- The other values (R and B) may change somewhat if the luminance is adjusted.

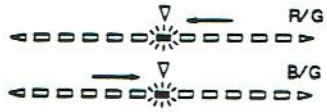
Analog display (G)

b. Adjust B beam intensity so that the value shown in the digital display for B becomes 100.

c. Adjust R beam intensity so that the value shown in the digital display for R becomes 100.



When all beam intensities have been adjusted so that the values shown in the digital display are all 100, the white displayed by the CRT is the same (xyY values are the same) as the standard color (W) stored in the selected memory channel.

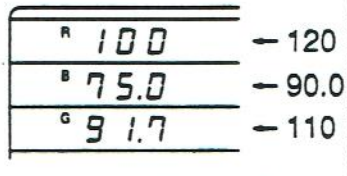


Analog display
(R/G, B/G)

If using an R-standard analyzer card (Analyzer Card-R CA-A15 or Multi-Probe Analyzer Card-R CA-A18):

a. Adjust luminance (or R beam intensity) first so that the value shown in the digital display for R becomes 100.

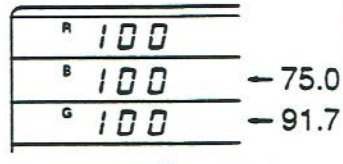
- The other values (B and G) may change somewhat if the luminance is adjusted.



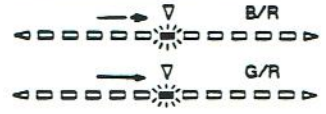
Analog display (R)

b. Adjust B beam intensity so that the value shown in the digital display for B becomes 100.

c. Adjust G beam intensity so that the value shown in the digital display for G becomes 100.



When all beam intensities have been adjusted so that the values shown in the digital display are all 100, the white displayed by the CRT is the same (xyY values are the same) as the standard color (W) stored in the selected memory channel.



Analog display
(B/R, G/R)

DATA COMMUNICATION

Data communication can be performed according to the RS-232C standard using the RS-232C terminal on the back of the CA-100 or, if the optional GP-IB Interface Board CA-A20 is installed, according to the GP-IB standards. The data formats for input of commands or output of measured data are the same for either data communication method.

RS-232C Data Communication

The CA-100 is equipped with an RS-232C terminal for data communication.

- If the optional GP-IB Interface Board CA-A20 is installed, data communication cannot be performed using the RS-232C terminal.

CONNECTION WITH COMPUTER

1. Set POWER switches of both the CA-100 and the computer to OFF.
2. Using the appropriate cable, connect the CA-100 and the computer according to the connection diagram below.

Pin diagram of CA-100's RS-232C terminal

Pin number	Signal	Input/ Output	Purpose
1	FG		Field ground
2	TXD	Output	Transmitted data
3	RXD	Input	Received data
4	RTS	Output	Request to send
5	CTS	Input	Clear to send
6	NC		Not connected
7	GND		Signal ground
8 through 19	NC		Not connected
20	DTR	Output	Data terminal ready
21 through 25	NC		Not connected

* Pin 20 normally outputs +5V.

Connection diagram

CA-100		Computer Pin number		
Pin number	Signal	Signal	Using 25-pin D-subminiature plug	Using 9-pin D-subminiature plug
1	FG	FG	1	NC
2	TXD	TXD	2	3
3	RXD	RXD	3	2
4	RTS	RTS	4	7
5	CTS	CTS	5	8
7	GND	DSR	6	6
20	DTR	GND	7	5

- Do not connect or disconnect the connecting cable while the computer or CA-100 are switched on.
- The internal connections of all RS-232C connecting cables are not the same. Check the internal connections of the cable before use.
- Set the POWER switch of the CA-100 to ON before switching on the computer. When switching off the system, switch off the computer before setting the POWER switch of the CA-100 to OFF.

COMMUNICATION PARAMETERS

The RS-232C communication parameters of the computer should be set to those of the CA-100 listed below.

Baud rate:	300, 600, 1200, 2400, 4800, 9600, 19200bps
Start bit:	1
Character length:	7 bits, ASCII code
Parity:	Even
Stop bits:	2

Setting Baud Rate

At the time of shipment, the baud rate of the CA-100 is set to 9600bps. The baud rate can be changed using the baud-rate selector DIP switches on the back of the CA-100. Set the POWER switch to **OFF**, set the switches to the positions corresponding to the desired baud rate, and then set POWER switch back to **ON**. The switch positions corresponding to the different baud rates are shown below.

Baud-rate selector DIP switches				Baud rate (bps)
MSB			LSB	
0	0	0	0	19200
1	0	0	0	9600
0	1	0	0	4800
1	1	0	0	2400
0	0	1	0	1200
1	0	1	0	600
0	1	1	0	300

- The above figure shows the switch settings at the time of shipment.

Note:
- The baud rate cannot be changed while the CA-100 is switched on. Even if the positions of the baud-rate selector DIP switches are changed while the CA-100 is switched on, the baud rate will not change and the baud rate which was set at the time the POWER switch was set from **OFF** to **ON** will continue to be used.
- Do not set the baud rate selector DIP switches to positions other than those shown above.

COMMUNICATION PROCEDURE

Inputting Commands

The commands listed starting on page 67 can be input to the CA-100 in ASCII code to control the operation of the CA-100.

Multiple commands can be input at one time by connecting the commands with the character "&". When commands are connected in this way, a command string of up to 250 characters (including & and delimiter code) can be created and input to the CA-100.

- When multiple-command strings are used, be sure to wait until all operations requested by the command string are completed before inputting another command.
- Any of three delimiter codes can be used after a command (when inputting single commands) or at the end of a command string (when inputting multiple commands connected by "&"): <CR> (carriage return), <LF> (line feed), or the combination of <CR> and <LF>.

To allow the computer to control the CA-100 via the RS-232C terminal, it is necessary to set the CA-100 to remote-control mode.

To set CA-100 to remote-control mode (REMOTE LED will light), do either of the following:

a. Press **REMOTE**, or
b. Input the command "F1" from the computer.

- While the CA-100 is in remote-control mode, the CA-100 will not respond to any key except **REMOTE**. However, luminance units can be changed using the luminance-unit selector switch.

To cancel remote-control mode, do either of the following:

a. Press **REMOTE** again, or
b. Input the command "F0" from the computer.

Outputting Data

The CA-100 can output the following four kinds of information to the computer when the CA-100 is set to remote-control mode:

a. Measurement data: Output after each measurement
b. Error messages: Output when a malfunction occurs with the CA-100; depending on error, remote-control mode may be canceled.
   - Error messages "E25", "E26", or "E27" will be output regardless of whether or not CA-100 is in remote-control mode or not.
c. Data recalled from memory: Output when the command "Kxx" (xx is the memory channel number from which data is desired) is input from the computer.
d. Status information: Output when the command "Z" is input from the computer.

<CR> (carriage return) is used as the delimiter for data output by the CA-100.

- If measurement data is not accepted by the computer within 0.5 seconds from the time preparation of the measurement data set has been completed, the measurement data will be discarded and the preparations for the next measurement data will begin. To signal that measurement data can be accepted by the computer, make the CTS pin of the RS-232C terminal active.
- The CA-100 will not accept any commands from the computer within approximately 0.5 seconds after data output has been completed.
- Data output will be interrupted and <CR> will be output in the following situations:
  a. A command was accepted in the middle of data output.
  b. An operation was started using one of the CA-100's keys or switches.
- If the CA-100 will not be controlled by the computer, it is recommended that the remote-control mode of the CA-100 is not set. If the remote-control mode is set but the computer is not ready to accept data, the time for one measurement becomes longer (by 0.5 seconds for each measuring probe being used) than the time required if remote-control mode is canceled.

Operation During Data Communication

Immediately after POWER switch is set to ON but before zero calibration has been performed, no measurements can be taken and thus no measurement data will be output. However, the following information can be output:

a. Data recalled from memory using the command "Kxx" (xx is the memory channel from which data is requested).
b. Status information requested using the command "Z"
c. Error messages related to input commands ("E4", "E10", "E11", or "E12")
d. Error messages related to performing zero calibration ("E21", "E29", or "E30")
e. Error messages relating to connections ("E25", "E26", or "E27")

Display hold

Display hold can be set by inputting the command "H1" from the computer. When display hold is set, the displayed data will not change and data output is only performed once for the data which was measured just before the command was input.

- If the command is input when no measurement data is present, the error code "E10" (command error) will be output. Measurement data will not be present in the following circumstances:
  a. After POWER switch is set to ON but before zero calibration is performed.
  b. After zero calibration has been performed but before any measurements have been taken.
  c. When the error message "NO SYNC. SIGNAL" is shown in the liquid crystal display.
- If the measurement data output when display hold is set is not accepted within 0.5 seconds, the measurement data will be discarded and the held measurement data cannot be output.
- While display hold is set, measurement data is not output. However, if measurement conditions are changed by inputting commands from the computer, the new measurement data (recalculated according to the new measurement conditions) will be output. If this data is not accepted within 0.5 seconds after it has been calculated, it will be discarded.
- Even while display hold is set, the following information can be output:
  a. Data recalled from memory using the command "Kxx" (xx is the memory channel from which data is requested).
  b. Status information requested using the command "Z"
  c. Error messages related to input commands ("E3", "E4", "E5", "E10", "E11", "E12", or "E13")
- If the command "I" is input while display hold is set, zero calibration will be performed and display hold will be canceled.

To cancel display hold, input the command "H0" from the computer.

Sample Program

```
1000  CLS
1010   PRINT "    CA-100 RS-232C COMMUNICATION PROGRAM            "
1020   ERRFLG = 0                                    :'Clear error_flag
1030   SD$ = "F1"                                    :'Remote on
1040     GOSUB 2030                                  :'Send command
1050   PRINT
1060   PRINT " Darken probe then press any key to perform 0-CAL "
1070   A$ = INKEY$
1080     IF A$ ="" THEN GOTO 1070
1090   SD$ = "I"                                     :'Start 0-CAL
1100     GOSUB 2030                                  :'Send command
1110     OPEN "COM1:9600,E,7,2,CS,DS" FOR INPUT AS #1
1120       LINE INPUT #1,RD$                         :'Read data
1130     CLOSE #1
1140     GOSUB 2100                                  :'Error check
1150 '
1160   IF RD$ <> "E21" THEN GOTO 1210
1170   PRINT " Too bright.                "
1180   PRINT " Darken probe.              "
1190  GOTO 1050
1200 '
1210 '#####     Select operation     #####"
1220 '
1230   CLS
1240   PRINT
1250   PRINT " Select operation.                  " : PRINT
1260   PRINT "   Read data     ---> Space key     "
1270   PRINT "   Send command  ---> C             "
1280   PRINT "   Quit          ---> Q             "
1290 '
1300   A$ = INKEY$
1310     IF A$="C" OR A$="c" THEN GOTO  1360       :'Send command
1320     IF A$=" " THEN GOTO  1510                 :'Measure
1330     IF A$="Q" OR A$="q" THEN GOTO  1670       :'Quit
1340   GOTO 1300
1350 '
1360 '#####     Send command     ######
1370 '
1380   PRINT
1390   INPUT " Enter command : ",CD$
1400     IF LEFT$(CD$,1)="K" OR CD$="Z" OR CD$="H1" THEN GOSUB 1740:GOTO 1240
1410     IF CD$ = "I" GOTO 1090
1420     OPEN "COM1:9600,E,7,2,CS,DS,LF" AS #1
1430       PRINT #1,CD$                            :'Send command
1440       LINE INPUT #1,RD$                       :'Read data
1450       IF RD$="E20" OR RD$="E2" OR RD$="E" THEN LINE INPUT #1,RD$
1460       IF LEFT$(RD$,1)<>"E" AND LEN(RD$)<13 THEN GOTO 1440
1470     CLOSE #1
1480     GOSUB 2100                                  :'Error check
1490  GOTO 1240                                      :'Return to command select
1500 '
1510 '#####     Measure          #####
1520 '
1530   PRINT
1540   PRINT " Hit space key again to stop measurement " : PRINT
1550   SD$ = "H0"                                    :'Hold off
1560   OPEN "COM1:9600,E,7,2,CS,DS" AS #1
1570     PRINT #1,SD$                                :'Send command
1580     LINE INPUT #1,RD$
1590     A$ = INKEY$
1600     IF A$ = " " THEN CLOSE #1:GOTO 1240         :'Return to operation select
1610     LINE INPUT #1,RD$                           :'Read data
1620       GOSUB 2100                                :'Error check
1630     IF ERRFLG = 1 THEN 1240                     :'Return to operation select
1640     PRINT RD$                                   :'Display data
1650   GOTO 1590
1660 '
1670 '#####     Quit           #####
```

```
1680 '
1690     SD$ = "F0"                                    :'Remote off
1700     GOSUB 2030                                    :'Send command
1710     PRINT : PRINT " COMMUNICATION ENDED !! "
1720  END
1730 '
1740 '#####     Command check   #####
1750 '
1760   OPEN "COM1:9600,E,7,2,CS,DS"  AS #1
1770     PRINT #1,"Z"                                  :'Send command
1780     LINE INPUT #1,RD$                             :'Read data
1790     IF LEFT$(RD$,1) <> "M" THEN GOTO 1780
1800   CLOSE #1
1810   IF CD$ = "Z" THEN PRINT : PRINT RD$ : RETURN
1820                                                  :'Check number of probe
1830     IF MID$(RD$,105,1)<>" " THEN OPNUM=5 : GOTO 1870
1840     IF MID$(RD$,104,1)<>" " THEN OPNUM=4 : GOTO 1870
1850     IF MID$(RD$,103,1)<>" " THEN OPNUM=3 : GOTO 1870
1860     IF MID$(RD$,102,1)<>" " THEN OPNUM=2 ELSE OPNUM=1
1870 '
1880   OPEN "COM1:9600,E,7,2,CS,DS" AS #1
1890     PRINT #1,CD$                                  :'Send command
1900     PRINT
1910    FOR I=1 TO OPNUM
1920      LINE INPUT #1,RD$                           :'Read data
1930      IF LEN(RD$)<5 GOTO 1920
1940      GOSUB 2100                                  :'Error check
1950      IF ERRFLG=1 THEN CLOSE #1 : RETURN
1960      IF LEFT$(RD$,1)<>"P" AND CD$="H1" THEN GOTO 1920
1970      IF LEFT$(RD$,1)<>"C" AND LEFT$(CD$,1)="K" THEN GOTO 1920
1980      PRINT RD$                                   :'Disply data
1990    NEXT I
2000   CLOSE #1
2010  RETURN
2020 '
2030 '#####     Send command     #####
2040 '
2050   OPEN "COM1:9600,E,7,2,CS,DS" FOR OUTPUT AS #1
2060     PRINT #1,SD$
2070   CLOSE #1
2080  RETURN
2090 '
2100 ' #####    Error check  #####
2110 '
2120   ERRFLG = 0                                     :'Clear error flag
2130   IF LEFT$(RD$,1)<>"E" THEN GOTO  2200
2140     PRINT
2150     PRINT " Error occurred. ";RD$
2160     IF RD$ = "E25" OR RD$ = "E26" OR RD$ = "E27" THEN RETURN 1670
2170     SD$ = "F1"    : CLOSE #1                     :'Remote on
2180     GOSUB 2030                                   :'Send command
2190    ERRFLG = 1                                    :'Set error flag
2200  RETURN
```

GP-IB Data Communication

- GP-IB data communication is available only when using the optional GP-IB Interface Board CA-A20.

The GP-IB (General-Purpose Interface Bus) standard is defined by IEEE Standard 488-1978 as a standard for interfacing measuring instruments and computers. In this system, a maximum of 15 instruments can be connected to the same bus. Data communication is in parallel form, allowing high-speed data transfer even for a large system.

The system is composed of a controller (computer), talker devices, and listener devices. Each device is assigned an address from 0 to 30. The controller is assigned one talker address and one or more listener addresses. Communication is then carried out between one talker and at least one listener.

The GP-IB bus structure consists of a data bus (eight signal lines), a data byte transfer control bus (three signal lines), and a general interface management bus (5 signal lines). The signal lines of the data byte transfer control bus and general interface management bus are shown below.

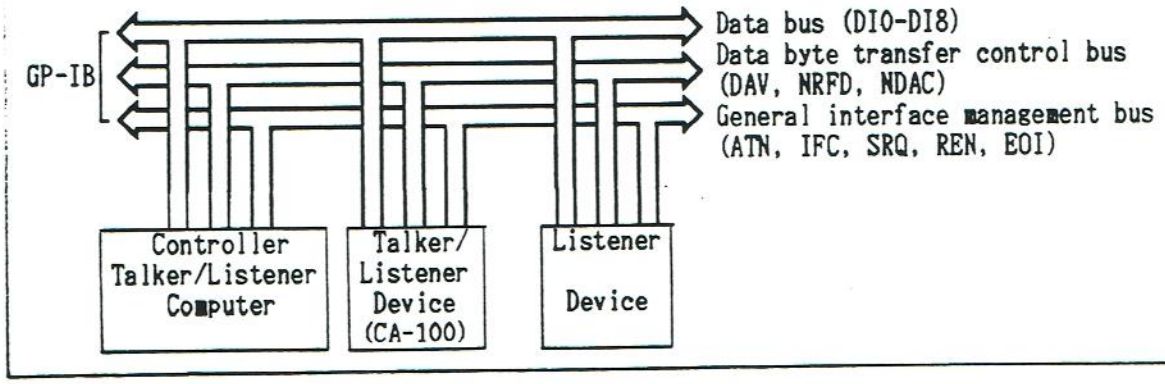
Data byte transfer control bus:

DAV	Data Valid; indicates condition (availability and validity) of information on the data bus.
NRFD	Not Ready For Data; indicates condition of readiness of device(s) to accept data.
NDAC	Not Data Accepted; indicates condition of acceptance of data by device(s).

General interface management bus:

ATN	Attention; specifies how data on the data bus are to be interpreted and which devices must respond to data.
IFC	Interface Clear; places the interface system in a known quiescent state.
SRQ	Service Request; indicates need for attention and requests interruption of current sequence of events.
REN	Remote Enable; enables or disables one or more local controls that have corresponding remote controls.
EOI	End or Identify; indicates the end of a multiple-byte transfer sequence or, when used by the controller (computer) in conjunction with ATN, executes polling sequence.

Block Diagram of GP-IB System

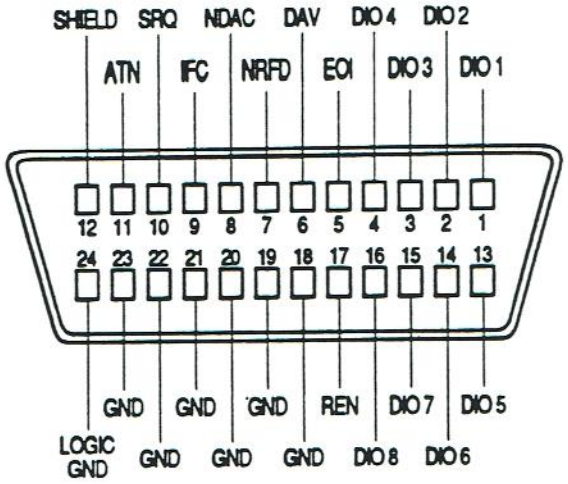


INTERFACE METHOD

Specifications:

Total cable length:	Within 20m (65.6 ft.)
Inter-device cable length:	Within 2m (6.6 ft)/connected device
Maximum number of connected devices:	15
Data communication method:	8-bit parallel with 3-line handshake
Logic:	Negative logic; signal levels: True (low): 0.8V or less False (high): 2.0V or more
Maximum communication rate:	1Mb/s

Pin Diagram



Communication Code Used: ASCII code

Interface Functions

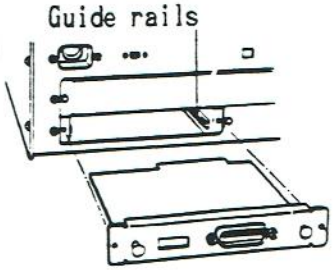
Code	Function
SH1	Source Handshake; all functions
AH1	Accepter Handshake; all functions
T6	Basic talker function; serial poll function; unaddress if MLA (My Listen Address); no talk only function
L4	Basic listener function; unaddress if MTA (My Talk Address); no listen only mode
SR1	Service request function
RL2	Remote local function; no local lockout function
PP0	No parallel poll function
DC1	Device clear; all functions
DT0	No device trigger function
C0	No controller function
E2	Use tri-state driver

INSTALLING OPTIONAL GP-IB INTERFACE BOARD CA-A20

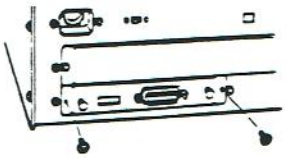
- Do not touch the gold contacts or any of the components on the GP-IB Interface Board. If the contacts become dirty, wipe them with a soft dry cloth.
- When the GP-IB Interface Board has been installed, it is not possible to perform data communication via the RS-232C terminal.

1. Set POWER switch to **OFF**.
2. Disconnect the AC power cord from the AC wall outlet. Pull on the plug, not on the cord.
3. Using a Phillips (cross-point) screwdriver, remove the two screws of the cover of the interface-board slot by turning them counterclockwise, and then remove the cover.

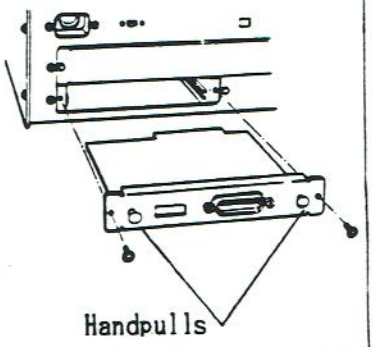
4. Align the edges of the GP-IB Interface Board with the grooves in the guide rails on each side of the interface-board slot and slide the GP-IB Interface Board fully into the slot in a straight line. Check that the board is firmly in place.



5. Insert one screw in the hole on each side of the GP-IB Interface Board and tighten until snug.



- To remove the GP-IB Interface Board, switch off the power and unplug the AC power cord, remove the two screws holding the GP-IB Interface Board in place, grasp the handpulls of the GP-IB Interface Board, and pull the board out of the slot in a straight line. After removing the GP-IB Interface Board, be sure to replace the cover of the interface-board slot.



NOTES ON CONNECTING CA-100 TO GP-IB SYSTEM

- Before connecting or disconnecting the CA-100 from the GP-IB system, check that the POWER switch of the CA-100 is at **OFF** and that the power to other devices in the GP-IB system is also switched off.
- Obey the specifications of the GP-IB system regarding inter-device and total cable length. (See p. 57.)
- Set the POWER switch of the CA-100 to **ON** before switching on the computer. When switching off the system, switch off the computer before setting the POWER switch of the CA-100 to **OFF**.

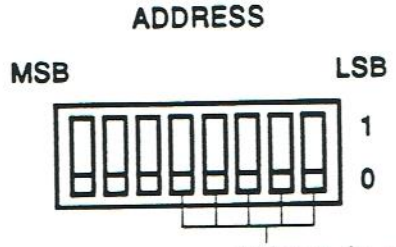
NOTES ON USING GP-IB SYSTEM

- If data communication via the GP-IB system will not be performed with a device, disconnect that device from the system.
- Do not disconnect devices or switch power on or off while data communication is in progress.
- If a problem occurs which may be due to any of the above actions, reset the entire system to attempt to correct the problem.

SETTING ADDRESS

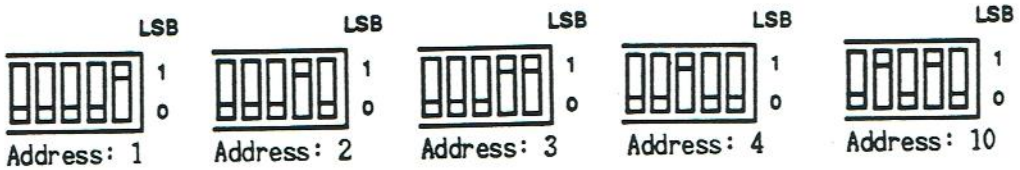
In order to use the CA-100 as part of a GP-IB system, it is necessary to set the address of the GP-IB board. The address is set using the address DIP switches on the back of the GP-IB board.

Address DIP switches



Address is set using these five switches.

The address is set in binary using the first five DIP switches from the right (from the LSB side). In the GP-IB system, acceptable addresses are from 0 to 30. At the time of shipment, the address is set to 0. To change the address, set POWER switch to OFF, change switch settings, and set POWER switch back to ON. Some examples of the switch positions for different addresses are shown below.



- Do not set the address to 31 (all five switches at 1).
- The address cannot be changed while the CA-100 is switched on. Even if the positions of the address DIP switches are changed while the CA-100 is switched on, the address will not change and the address which was set at the time the POWER switch was set from **OFF** to **ON** will continue to be used.

COMMUNICATION PROCEDURE

Inputting Commands

In addition to the ASCII commands listed starting on page 67, the address commands (GTL and SDC) and universal commands (DCL, SPE, and SPD) can be used to control the CA-100 from the controller (computer).

Multiple commands can be input at one time by connecting the commands with the character "&". When commands are connected in this way, a command string of up to 250 characters (including & and delimiter code) can be created and input to the CA-100.

- When multiple-command strings are used, be sure to wait until all operations requested by the command string are completed before inputting another command.
- Any of three delimiter codes can be used after a command (when inputting single commands) or at the end of a command string (when inputting multiple commands connected by "&"): <CR> (carriage return), <LF> (line feed), or the combination of <CR> and <LF>.

To allow the controller (computer) to control the CA-100 via the GP-IB system, it is necessary to set the CA-100 to remote-control mode.

To set CA-100 to remote-control mode (REMOTE LED will light):
Set the REN signal of the GP-IB to true (low) and transmit the address of the CA-100 to designate the CA-100 as a listener.

- While the CA-100 is in remote-control mode, the CA-100 will not respond to any key except **REMOTE**.

To cancel remote-control mode, do one of the following:
a. Press **REMOTE** again,
b. Set the REN signal of the GP-IB to false (high), or
c. Transmit the address command GTL

Service Request

Service request is an interrupt signal which can be output from the CA-100 to the controller (computer) to indicate a malfunction. When a malfunction occurs, the SQR signal becomes true (low).

Whether or not the service request is used or not can be selected by the user by inputting the following commands:

Command	Purpose
"Q0"	Sets CA-100 to not use service request (SQR signal not output); set at time of shipment
"Q1"	Sets CA-100 to use service request (SQR signal output)

If service request will be used, the SQR signal will be output if any of the following errors occur:

E3, E4, E5, E10, E11, E13, E25, E26, or E27

After the SQR signal from the CA-100 becomes true (low), wait for the controller (computer) to perform a serial poll. (During this time, the REMOTE LED will be blinking.) While the controller is performing the serial poll, the CA-100 will be designated as a talker; whether or not the ATN signal has become false (high) will be checked, the SQR signal will be set to false (high), and the status byte will be sent to the controller.

Status byte

Bit number	Value	Explanation
0	0	Not used
1	0	Not used
2	1	Error E25, E26, or E27 occurred
	0	Error E25, E26, or E27 did not occur
3	0	Not used
4	1	Error E3, E4, or E5 occurred
	0	Error E3, E4, or E5 did not occur
5	1	Error E10, E11, or E13 occurred
	0	Error E10, E11, or E13 did not occur
6	1	Service request situation
	0	Not service request situation
7	0	Not used

After this, the CA-100 will again be designated as a talker and the error message will be sent to the controller (computer).

- If the error is E3, E4, E5, E10, E11, or E13, remote-control mode will be canceled after the error message has been output.
- While the REMOTE LED is blinking, the data shown in the displays will not be correct.

Outputting Data

The CA-100 can output the following four kinds of information to the controller (computer) when the CA-100 is set to remote-control mode:

a. Measurement data:	Output after each measurement
b. Error messages:	Output when a malfunction occurs with CA-100; depending on error, remote-control mode may be canceled.
c. Data recalled from memory:	Output when the command "Kxx" (xx is the memory channel number from which data is desired) is input from the controller (computer).
d. Status information:	Output when the command "Z" is input from the controller (computer).

- The delimiter which will be used by the CA-100 for data output can be selected using the commands below:
  "D0": Sets <CR> (carriage return) and <LF> (line feed) as the delimiter; set at time of shipment
  "D1": Sets <LF> as the delimiter
- If measurement data are not accepted by the controller (computer) within 0.5 seconds from the time preparation of the measurement data set has been completed, the measurement data will be discarded and the preparations for the next measurement data will begin. To signal that data can be accepted by the controller, set the CA-100 to talker by setting the GP-IB data byte transfer control lines as follows:
  DAV: False (high)
  NRFD: True (low)
  NDAC: True (low)
- Data output will be interrupted and the delimiter will be output in the following situations:
  a. A command was accepted in the middle of data output.
  b. An operation was started using one of the CA-100's keys or switches.
- If the CA-100 will not be controlled by the controller (computer), it is recommended that the remote-control mode of the CA-100 is not set. If the remote-control mode is set but the controller is not ready to accept data, the time for one measurement becomes longer (by 0.5 seconds for each measuring probe being used) than the time required if remote-control mode is canceled.

Operation During Data Communication

Immediately after POWER switch is set to ON but before zero calibration has been performed, no measurements can be taken and thus no measurement data will be output. However, the following information can be output:

a. Data recalled from memory using the command "Kxx" (xx is the memory channel from which data is requested).
b. Status information requested using the command "Z"
c. Error messages related to input commands ("E4", "E10" or "E11")
d. Error messages related to performing zero calibration ("E21", "E29", or "E30")
e. Error messages relating to connections ("E25", "E26", or "E27")

Display hold

Display hold can be set by inputting the command "H1" from the controller (computer). When display hold is set, the displayed data will not change and data output is only performed once for the data which was measured just before the command was input.

- If the command is input when no measurement data is present, the error code "E10" (command error) will be output. Measurement data will not be present in the following circumstances:
  a. After POWER switch is set to ON but before zero calibration is performed.
  b. After zero calibration has been performed but before any measurements have been taken.
  c. When the error message "NO SYNC. SIGNAL" is shown in the liquid crystal display.
- If the measurement data output when display hold is set is not accepted within 0.5 seconds, the measurement data will be discarded and the held measurement data cannot be output.
- While display hold is set, measurement data is not output. However, if measurement conditions are changed by inputting commands from the controller (computer), the new measurement data (recalculated according to the new measurement conditions) will be output.
- Even while display hold is set, the following information can be output:
  a. Data recalled from memory using the command "Kxx" (xx is the memory channel from which data is requested).
  b. Status information requested using the command "Z"
  c. Error messages related to input commands ("E3", "E4", "E5", "E10", "E11", or "E13")
- If the command "I" is input while display hold is set, zero calibration will be performed and display hold will be canceled.

To cancel display hold, input the command "H0" from the controller (computer).

Sample Program

The sample program listed on the following pages is intended for use with an IBM personal computer in which the IBM GPIB Adapter (GPIB interface board) has been installed. For more detailed information, refer to IBM's Guide to the General Purpose Interface Bus Adapter Programming Support.

```
1000 CLEAR ,58002!                                      :' ***** = (Free bytes)-2223
1010 IBINIT1 = 58002!                                   :'Bload area
1020 IBINIT2 = IBINIT1 + 3
1030 BLOAD "A:BIB.M", IBINIT1                           :'GPIB control routine
1040                                                  ' Set up function routine address
1050 CALL IBINIT1(IBFIND,IBSTOP,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,
IBRSC,IBSRE,IBRSV,IBPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT)
1060 CALL IBINIT2(IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRTF,IBWRTA,IBWRT,IBCMDA,IBCMD,IBR
DF,IBRDA,IBRD,IBRPP,IBRSP,IBDIAG,IBXTRC,IBSTA%,IBERR%,IBCNT%)
1070 '
1080 CLS
1090  PRINT "      CA-100 GPIB COMMUNICATION PROGRAM " : PRINT
1100 DEV$="DEV6"                                        :'Device name (CA-100)
1110 ADP$="GPIB0"                                       :'GPIB interface
1120 CALL IBFIND(DEV$,DEV%)                             :'Get device
1130    IF DEV%<0 THEN GOTO 2260                        :'GPIB error
1140 CALL IBFIND(ADP$,ADP%)                             :'Get adapter
1150    IF ADP%<0 THEN GOTO 2260                        :'GPIB error
1160 CALL IBSIC(ADP%)                                   :'Send interface clear
1170 V%=1 : CALL IBSRE(ADP%,V%)                         :'Set remote enable line
1180   LF$=CHR$(&HA)                                    :'Line feed code
1190 PRINT " CA-100 address = 6 " : PRINT
1200   RD0$=SPACE$( 135 )                               :'Read data buffer
1210 '
1220 '#####      CA-100 set up      #####
1230 '
1240 WRT$="D1" : GOSUB 2000                             :'Delimiter = LF
1250 WRT$="Q0" : GOSUB 2000                             :'Disable service requests
1260 '
1270 '#####      CA-100 0-calibration      #####
1280 '
1290 PRINT "  Darken probe then press any key to perform "
1300   A$ = INKEY$
1310   IF A$ ="" THEN GOTO 1300
1320   WRT$ = "I" : GOSUB 2000                          :'0-CAL
1330   GOSUB 2080
1340   IF RD$ <> "E21" GOTO 1380                        :'Return to operation select
1350   PRINT : PRINT " Too Bright" : PRINT " Darken probe " : PRINT
1360 GOTO 1290
1370 '
1380 '#####      Select operation      #####
1390 '
1400   CLS
1410    PRINT
1420    PRINT "   Select operation                "  : PRINT
1430    PRINT "     Read data     ---> Space key "
1440    PRINT "     Send command  ---> C           "
1450    PRINT "     Quit          ---> Q           "  : PRINT
1460   A$ = INKEY$
1470     IF A$="C" OR A$="c" THEN GOTO 1520           :'Send command
1480     IF A$=" "           THEN GOTO 1640           :'Read data
1490     IF A$="Q" OR A$="q" THEN GOTO 1750           :'Quit
1500   GOTO 1460
1510 '
1520 '#####      Send command      #####
1530 '
1540   INPUT "Enter command : ",SD$
1550     PRINT
1560     IF LEFT$(SD$,1) ="K"  THEN GOTO 1820        :'Check command
1570     IF SD$          ="Z"  THEN GOTO 1820
1580     IF SD$          ="H1" THEN GOTO 1820
1590     IF SD$          ="I"  THEN GOTO 1270
1600     WRT$=SD$ : GOSUB 2000                        :'Send command
1610     GOSUB 2080
1620   GOTO 1410
1630 '
1640 '#####      Read data      #####
1650 '
```

```
1660   PRINT " Hit space key again to stop measurement " : PRINT
1670   WRT$="H0" : GOSUB 2000                          :'Hold off
1680   A$=INKEY$
1690     IF A$ =" " THEN 1410                          :'Return to command select
1700   GOSUB 2080
1710     IF ERRFLG=1 THEN 1410                         :'Return to command select
1720   PRINT RD$                                       :'Display data
1730  GOTO 1680
1740  '
1750  '#####     Quit     #####
1760  '
1770   CALL IBLOC(DEV%)
1780       IF IBSTA% < 0 THEN GOTO 2260                :'Status check
1790   PRINT " COMMUNICATION ENDED !! "
1800   END
1810  '
1820  '#####     Check command    #####
1830  '
1840   WRT$="Z" : GOSUB 2000                           :'Status read
1850    GOSUB 2080
1860    IF SD$="Z" THEN PRINT RD$ : GOTO 1980
1870    IF LEN(RD$)=101 OR MID$(RD$,102,1)=" " THEN OPNUM=1 : GOTO 1910
1880    IF LEN(RD$)=102 OR MID$(RD$,103,1)=" " THEN OPNUM=2 : GOTO 1910
1890    IF LEN(RD$)=103 OR MID$(RD$,104,1)=" " THEN OPNUM=3 : GOTO 1910
1900    IF LEN(RD$)=104 OR MID$(RD$,105,1)=" " THEN OPNUM=4 ELSE OPNUM=5
1910  '
1920    WRT$=SD$ : GOSUB 2000                         :'Send command "H1" or "K**"
1930    FOR I=1 TO OPNUM
1940      GOSUB 2080
1950      IF ERRFLG=1 THEN 1980
1960      PRINT RD$
1970    NEXT I
1980    GOTO 1410
1990  '
2000  '#####     Write command to CA-100   #####
2010  '
2020    WRT$ = WRT$ + LF$ : LIS$ = "?@&"
2030    CALL IBCMD(ADP%,LIS$)                         :'Send command
2040    CALL IBWRT(ADP%,WRT$)                         :'Send command
2050       IF IBSTA% < 0 THEN GOTO 2260               :'Status check
2060   RETURN
2070  '
2080  '#####     Read data from CA-100     #####
2090  '
2100           TAK$ = "?F "
2110    CALL IBCMD(ADP%,TAK$)
2120    CALL IBRD(ADP%,RD0$)
2130       IF IBSTA%<0 THEN GOTO 2260                 :'Status check
2140    J=INSTR(RD0$,CHR$(10))                        :'Read data
2150    RD$=LEFT$(RD0$,J-1)
2160    ERRFLG=0                                      :'Error flag clear
2170    IF LEFT$(RD$,1)<>"E" THEN GOTO 2240
2180    ERRFLG=1
2190    PRINT "  Error occurred : ";RD$
2200    IF RD$="E25" OR RD$="E26" OR RD$="E27" THEN GOTO 1750
2210    CALL IBSIC(ADP%)
2220    V%=1 : CALL IBSRE(ADP%,V%)
2230    CALL IBCMD(ADP%,LIS$)
2240    RETURN
2250  '
2260  '#####     GPIB error     #####
2270  '
2280    PRINT "  GPIB error !!  "
2290    PRINT "ibsta%= " ; HEX$(IBSTA%)
2300    PRINT "iberr%= " ; HEX$(IBERR%)
2310    PRINT "  adp%= " ; HEX$(ADP%)
2320    PRINT "  dev%= " ; HEX$(DEV%)
2330    GOTO 1750                                     :'Quit
```

Communication Format

COMMANDS

The commands listed in the following tables can be used to control the CA-100. Most of the commands listed are applicable to data communication with both RS-232C and GP-IB systems; those that are applicable to only one system are indicated as such.

Command	Function	Input format	Further information
I	Performs zero calibration	"I"	● Block all light from reaching the receptor area of measuring probes before inputting this command. ● Until this command is input and zero calibration is completed, the commands U, A, N, J, and E will not be accepted. (Do not string the command I together with other commands using "&".) ● Corresponds to pressing **0-CAL**.
M	Selects display mode	"M0": Sets xyY display mode "M1": Sets T⊿uvY display mode "M2": Sets analyzer (RBG) display mode (if optional Analyzer Card inserted)	● Corresponds to pressing **MODE**.
S	Selects SYNC mode	"S0": Sets NTSC SYNC mode "S1": Sets PAL SYNC mode "S2": Sets EXT SYNC mode "S3": Sets UNIV. SYNC mode	● Corresponds to pressing **SYNC**.
H	Sets/cancels display hold	"H0": Cancels display hold "H1": Sets display hold	● Corresponds to pressing **HOLD**.
U	Setting user-selected calibration data or standard color data (for memory channel 00)	"U [x value : y value : Y value]" ● x value or y value can be input in any of the three formats given in the examples below for inputting the value 0.330: "0.330" ".330" "330" Spaces must not be input before or after data. ● Y value Acceptable range: 0.01 to 999 Number of characters: Up to 4 (including decimal point) Spaces must not be input before or after data.	● Corresponds to pressing **CAL** in xyY or T⊿uvY display mode. ● Cannot be used in analyzer mode (even with optional Analyzer Card inserted). ● Although **ENTER** would be pressed to complete input of data if the operation were performed using the CA-100's keys, pressing **ENTER** or inputting the corresponding command "E" is not necessary. If "E" is input, the CA-100 will store the present measured data as the standard color data. ● This command will not be accepted unless "I" has been input and zero calibration has been completed.

Command	Function	Input format	Further information
A	Sets range of analog display	a. In xyY or T⊿uvY display mode: "A [range of ⊿x, ⊿y : range of ⊿Y]" b. In analyzer mode, G standard: "A [range of ⊿G : range of R/G, B/G]" c. In analyzer mode, R standard: "A [range of ⊿R : range of G/R, B/R]" Acceptable range: 0.1 to 99 Number of characters: Up to 3 (including decimal point) Spaces must not be input before or after data.	● Corresponds to pressing **RANGE**. ● Although **ENTER** would be pressed to complete input of data if the operation were performed using the CA-100's keys, pressing **ENTER** or inputting the corresponding command "E" is not necessary. If "E" is input, the CA-100 will store the present measured data as the standard color data. ● This command will not be accepted unless "I" has been input and zero calibration has been completed. ● Range data remains in memory even if CA-100 is switched off.
C	Sets memory channel	"C [memory channel number]" Acceptable range: 00 to 10 (If optional Memory Card inserted, acceptable range becomes 00 to 99.)	● Corresponds to pressing **MEMORY CH** ∧or∨ .
N	Inputs ID label	"N [memory channel number] [10-character ID label]" or "N [10-character ID label]" Acceptable range of memory channel number: 00 to 10 (If optional Memory Card inserted, acceptable range becomes 00 to 99.)	● If memory channel number is omitted, memory channel presently being used will be set. ● Corresponds to pressing **ID**. ● Although **ENTER** would be pressed to complete input of data if the operation were performed using the CA-100's keys, pressing **ENTER** or inputting the corresponding command "E" is not necessary. If "E" is input, the CA-100 will store the present measured data as the standard color data. ● This command will not be accepted unless "I" has been input and zero calibration has been completed. ● ID label will remain in memory even if CA-100 is switched off.
P	Sets probe connector number for which data will be displayed	When using Multi-Probe Expansion Board CA-A13 only: "P [probe connector number]" Acceptable range: 1 to 5	● Probe connector number to which no probe is connected cannot be selected. ● Corresponds to pressing **PROBE**.

Command	Function	Input format	Further information
0	Sets probe connector number for which data will be output	When using Multi-Probe Expansion Board CA-A13 only: "0 probe connector number " Acceptable range: 0 to 5 If data output for more than one probe connector is desired, more than one probe connector number can be input. For example, "0134" will cause data from measuring probes connected to probe connectors 1, 3, and 4 to be output. For data output from measuring probes connected to all probe connectors, input 0 as the probe connector number: "00"	● Probe connector number to which no probe is connected cannot be selected. ● The presently selected probe connector number for data output can be determined by using the command "Z" (status information request). ● If probe connector number for which data will be output is not selected after POWER switch is first set to ON, the probe connector number for data output will be the same as the probe connector number for which data will be displayed.
L	Sets presently selected settings as default settings	"L"	● Changes the default settings (settings which are automatically set when POWER is first set to ON) for the following items: a. Display mode b. SYNC mode c. Memory channel d. Probe connector for which data will be displayed (only when using optional Multi-Probe Expansion Board CA-A13) ● Corresponds to pressing PROBE while CURSOR ▶ is held pressed.
J	Sets calibration mode when CA-100 is set to analyzer (RBG) display mode (available only with an optional Analyzer Card)	When using optional Analyzer Card only: "J0": Calibration mode off "J1": Calibration mode on ● Calibration mode is the mode which the CA-100 enters when CAL is pressed.	● If the command "J0" (calibration mode off) is input after RBGW data has been set but before the command "E" (ENTER) is input, the RBGW data just set will be deleted. ● If the command I, M, A, C, N, or P is input, calibration mode will automatically be canceled. ● Corresponds to pressing CAL when CA-100 is in analyzer mode. ● This command will not be accepted unless "I" has been input and zero calibration has been completed.
R B G W	For input of RGB emission characteristics for CRT phosphors [available only in analyzer (RBG) display mode when using optional Analyzer Card]	When using optional Analyzer Card only: "R": Sets R emission value "B": Sets B emission value "G": Sets G emission value "W": Sets W (standard white value)	● Will be accepted only when calibration mode has been set (by pressing CAL or by inputting the command "J1"). ● Correspond to pressing 4, 1, 0, and 7 respectively after CAL has been pressed in analyzer mode.

Command	Function	Input format	Further information
E	ENTER	"E"	● Sets present displayed data as standard color data in xyY or TΔuvY display modes (or in analyzer mode if calibration mode is off). ● Stores previously set RBGW values in memory when calibration mode is switched on (if RBGW values have all been set correctly). ● Corresponds to pressing ENTER. ● This command will not be accepted unless "I" has been input and zero calibration has been completed.
K	Recalls standard color data from memory	"K [memory channel number]" Acceptable range: 00 to 10 (If optional Memory Card inserted, acceptable range becomes 00 to 99.)	● Standard color data is output for all probe connector numbers selected for data output. ● For format of output data, see p. 74. ● The data output as a result of this command must be accepted before the next command is input.
Z	Requests status information regarding present settings	"Z"	● The following status information will be output: a. Display mode b. SYNC mode c. Memory channel number d. ID label e. Analog display range f. Luminance units g. Probe connector number for which data is displayed h. Probe connector number (or numbers) for which data is output i. Calibration mode on or off j. RBGW values set or not ● For format of output data, see p. 75. ● The data output as a result of this command must be accepted before the next command is input.

For data communication via RS-232C terminal only:

Command	Function	Input format	Further information
F	Sets remote-control mode off or on	"F0": Remote-control mode off "F1": Remote-control mode on	● If remote-control mode is set to off, the only acceptable input via the RS-232C terminal is the command "F1".

For data communication using GP-IB system only:
(Available only when optional GP-IB Interface Board has been installed)

Command	Function	Input format	Further information
Q	Activates or inactivates service request function	"Q0": Service request inactive "Q1": Service request active	● This setting will be stored in the memory of the CA-100 and will remain in memory until changed by the user, even if the POWER switch is set to OFF.
D	Sets delimiter for data output	"D0": Delimiter is <CR> and <LF> "D1": Delimiter is <LF>	● The selected delimiter is added to data output by the CA-100. The delimiter used for input to the CA-100 can be <CR> (carriage return), <LF> (line feed), or the combination of <CR> and <LF>. ● This setting will be stored in the memory of the CA-100 and will remain in memory until changed by the user, even if the POWER switch is set to OFF.

OUTPUT DATA

Measurement Data

Measurement data is output by the CA-100 according to the present display mode. However, the format of the output data will be slightly different from the format of the displayed data.

- When using the optional Multi-Probe Expansion Board CA-A13, the probe connector number for which data will be output should be selected using the command:
  "O [probe connector number]"

- In the following, "_" indicates a space.

Display mode: ΔxyY
Format: P[probe connector number]_[x value];[y value];[Y value][delimiter]
Example: P1_310;330;_150[delimiter]

Probe connector number: Value from 1 to 5; probe connector number for which data is being output. In example, data is being output for probe connector P1.

x value, y value: First three decimal places output. In example, x = 0.310 and y = 0.330.

Y value: Up to four characters output; if value consists of fewer than four characters, value will be preceded by the required number of spaces. In example, Y = 150.

Display mode: TΔuvY
Format: P[probe connector number]_[T value];[Δuv value];[Y value][delimiter]
Example: P1__6500;_005;_150[delimiter]

Probe connector number: Value from 1 to 5; probe connector number for which data is being output. In example, data is being output for probe connector P1.

T value: Up to five characters output; if value consists of fewer than five characters, value will be preceded by the required number of spaces. In example, T = 6500.

Δuv value: First three decimal places output; preceded by a space if positive or "-" if negative. In example, Δuv = +0.005.

Y value: Up to four characters output; if value consists of fewer than four characters, value will be preceded by the required number of spaces. In example, Y = 150.

Display mode: Analyzer (RBG)

- Analyzer (RBG) display mode is available only with an optional Analyzer Card.

Format: P[probe connector number]_[R value];[B value];[G value][delimiter]
Example: P1___101;_99.0;__114[delimiter]

Probe connector number: Value from 1 to 5; probe connector number for which data is being output. In example, data is being output for probe connector P1.

R value, B value, G value: Up to five characters output; if value consists of fewer than five characters, value will be preceded by the required number of spaces. In example, R = 101, B = 99.0, and G = 114.

When using optional Multi-Probe Expansion Card CA-A13:

When using Multi-Probe Expansion Card CA-A13, data output for more than one probe connector number can be selected if desired. If more than one probe connector number is selected, data will be output consecutively for all selected probe connector numbers in numerical order.

Format: P [probe connector number] _ [measurement data*] [delimiter]
P [probe connector number] _ [measurement data*] [delimiter]
:
:
P [probe connector number] _ [measurement data*] [delimiter]

- Measurement data is output according to the format above for the selected display mode.

Data Recalled From Memory

Standard color data in memory can be recalled and output using the command "Kxx", where xx is the memory channel number from which data is desired. The data which will be recalled and output depends on the present display mode.

- When using the optional Multi-Probe Expansion Board CA-A13, the probe connector number for which data will be output should be selected using the command: "O [probe connector number]".

- In the following, "_" indicates a space.

Format: CH[memory channel number]_P[probe connector number][[serial number (a)]][[serial number (b)]]_[standard color data][delimiter]

Memory channel number: Value from 00 to 99; memory channel number from which data is being recalled and output.

Probe connector number: Value from 1 to 5; probe connector number for which data is being output.

Serial number (a): 8 characters;
For xyY or TΔuvY display mode:
Serial number of probe used for calibration to a user-selected reference.
For analyzer (RBG) display mode:
Serial number of probe used for setting RGB emission characteristics of CRT phosphors.

Serial number (b): 8 characters; serial number of probe used for setting standard color data.

Standard color data: For xyY or TΔuvY display mode:
Format: [x value];[y value];[Y value]
x, y values: First three decimal places output.
Y value: Up to four characters output; if value consists of fewer than four characters, value will be preceded by the required number of spaces.
For analyzer (RBG) display mode:
Format: [R value];[B value];[G value]
R, B, G values: Up to five characters output; if value consists of fewer than five characters, value will be preceded by the required number of spaces.

When using optional Multi-Probe Expansion Card CA-A13:
When using Multi-Probe Expansion Card CA-A13, data output for more than one probe connector number can be selected if desired. If more than one probe connector number is selected, data will be output consecutively for all selected probe connector numbers in numerical order.

Format: CH[memory channel number]_P[probe connector number]_[standard color data*][delimiter]
CH[memory channel number]_P[probe connector number]_[standard color data*][delimiter]
:
:
CH[memory channel number]_P[probe connector number]_[measurement data*][delimiter]

- Standard color data is output according to the format above for the selected display mode.

Status Information

Inputting the command "Z" will cause the present settings and status of the CA-100 to be output as a 134-character word as shown below.

- In the following, "_" indicates a space.

Format: [display mode] [SYNC mode] [memory channel number and ID label] [analog display range] [luminance unit] [probe connector number for display] [probe connector number for output] [calibration mode on/off in analyzer mode] [WRGB values input status] [delimiter]

Example: MODE:RGB_____SYNC:NTSC___CH01[MINOLTA___]__RANGE__R:1.0%_GB:2.0%___
LUMI.:fL_______DISP-P:1___OUT-P:135_____CAL:ON____W:*_R:*_G:__B:*_[delimiter]

Content	Number of characters	Format
Display mode	13	MODE:xyY_____ (For xyY display mode) MODE:TduvY___ (For TΔuvY display mode) MODE:RGB_____ (For analyzer (RBG) display mode) In example, display mode is set to analyzer (RBG) display mode.
SYNC mode	12	SYNC:NTSC___ (For NTSC mode) SYNC:PAL____ (For PAL mode) SYNC:EXT____ (For EXT mode) SYNC:UNIV___ (For UNIV. mode) In example, SYNC mode is set to NTSC.
Memory channel number and ID label	19	CH[memory channel number][[ID label]]___ Memory channel number: Two characters ID label: Ten characters In example, memory channel 01 is selected and ID label is "MINOLTA".
Analog range	24	RANGE_xy:[range]%_Y:[range]%___ (For xyY or TΔuvY display mode) RANGE__G:[range]%_RB:[range]%___ (For analyzer (RBG) display mode; G standard) RANGE__R:[range]%_GB:[range]%___ (For analyzer (RBG) display mode; R standard) Range: Three characters; if actual value fewer than three characters, value will be preceded by required number of spaces. In example, analog display range for R is set to 1.0% and the range for B and G is set to 2.0%.
Luminance unit	15	LUMI.:cd/m*m___ (For cd/m^2) LUMI.:fL_____ (For fL) In the example, the luminance unit is fL.
Probe connector number for display	11	DISP-P:[probe connector number for display]___ Probe connector number for display: One character; 1 to 5 In example, probe connector number P1 was selected for display.
Probe connector number for output	14	OUT-P:[probe connector numbers for output]___ Probe connector numbers for output: Up to five characters; 1 to 5; if fewer than five characters, remaining characters will be spaces. In example, probe connector numbers P1, P3, and P5 were selected for output.

Content	Number of characters	Format
Calibration mode on/off in analyzer (RBG) display mode*	10	CAL:ON___ (If calibration mode on) CAL:OFF___ (If calibration mode off) In example, calibration mode for analyzer mode is on.
WRBG values input status**	16	W:#_R:#_G:#_B:#_ #: * if value has already been input; _ if value has not been input yet In example, values for W, R, and B have been input but value for G has not been input yet.

* Calibration mode on/off in analyzer (RBG) display mode will be output only when analyzer (RBG) display mode is set.

** WRBG values input status will be output only when calibration mode is on in analyzer (RBG) display mode.

Error Messages

Error messages which may be output by the CA-100 when remote-control mode has been set are listed below.

- For information on error messages which may appear in the liquid crystal display, see p. 89.
- In the following, "_" indicates a space.

	Error message format	Explanation
*	[Measurement data] _P	Present measuring probe and measuring probe used for calibration to a user-selected reference or for setting standard color (or for inputting RGB emission characteristics of CRT phosphors in analyzer mode) are different. (Liquid crystal display error message: E1)
*	[Measurement data] _T	Ambient temperature has changed since zero calibration was performed. (Liquid crystal display error message: E2)
*	[Measurement data] _F	Measured data is outside of measuring range. (Digital display blinking)
	E3__;[command which caused error (up to 20 characters)]	Error in setting calibration values for user-selected reference. Remote-control mode canceled; new or additional commands not accepted.
	E4__;[command which caused error (up to 20 characters)]	0% was set as analog display range. Remote-control mode canceled; new or additional commands not accepted.
	E5__;[command which caused error (up to 20 characters)]	The command "E" was input before acceptable data was input for all four values (R, G, B, and W) when inputting RGB emission characteristics for CRT phosphors. Remote-control mode canceled; new or additional commands not accepted.
	E10__;[command which caused error (up to 20 characters)]	The input command is not acceptable. Remote-control mode canceled; new or additional commands not accepted.
	E11	A command string of more than 250 characters was input. Remote-control mode canceled; new or additional commands not accepted.
	E12	Error in RS-232C data communication. A command was input while CA-100 was unable to accept commands. Remote-control mode canceled; new or additional commands not accepted.
	E13	The command "E" was input to input the standard color (W) while "OVER" was displayed in the liquid crystal display. Remote-control mode canceled; new or additional commands not accepted.
	E20	Liquid crystal display error message: NO SYNC. SIGNAL
	E21	Liquid crystal display error message: TOO BRIGHT

	Error message format	Explanation
	P [probe connector number (1 to 5)] _E22	Liquid crystal display error message: OVER
	P [probe connector number (1 to 5)] _E23	Liquid crystal display error message: OFFSET ERROR PUSH 0-CAL KEY
	P [probe connector number (1 to 5)] _E24; [Luminance value Y (up to four characters)]	Measured value is over display range in TΔuvY display mode.
**	E25	Liquid crystal display error message: SET MAIN PROBE
**	E26	Liquid crystal display error message: PROBE ERROR
**	E27	Liquid crystal display error message: MEMORY CARD ERROR
	P [probe connector number] _E28	Liquid crystal display error message: DATA ERROR
	E29	Liquid crystal display error message: DARKEN PROBE
	E30	Liquid crystal display error message: DARKEN PROBE PUSH 0-CAL KEY

* If the conditions for more than one of these error messages occur, the appropriate error messages will be strung together. For example, if the conditions for all three error messages occurred:

[Measurement data] _P_T_F

would be output as the error message.

** If the conditions for any of these messages occur, the appropriate error message will be output continuously as long as the power is on, and new or additional commands will not be accepted. If this occurs, switch power off and then switch it on again. (When performing RS-232C data communication, these messages will be output regardless of whether remote-control mode is on or off.)

MEASURING PRINCIPLE

General Information

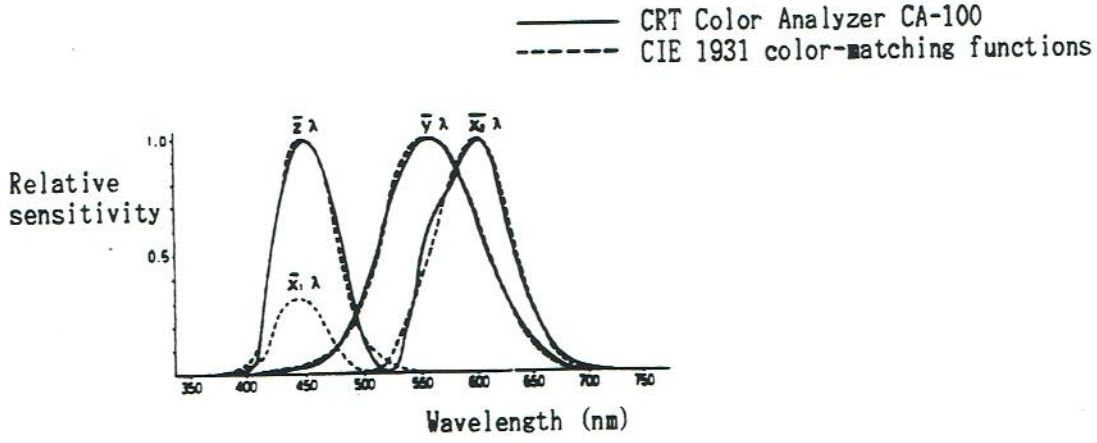
A CRT screen is equipped with phosphors to emit red, green, and blue light. When the electron beam inside the CRT strikes these phosphors, the phosphors emit their respective colors, and these colors are combined on the CRT screen to form an image.

The CA-100 uses sensors filtered to closely match the CIE 1931 $x_2\lambda$, $y\lambda$, and $z\lambda$ color-matching functions to measure the energy of the light emitted by the CRT phosphors. The measured values are then displayed as x, y, Y or T, Δuv, Y values. (With an optional Analyzer Card, the measured values can be displayed in analyzer mode.)

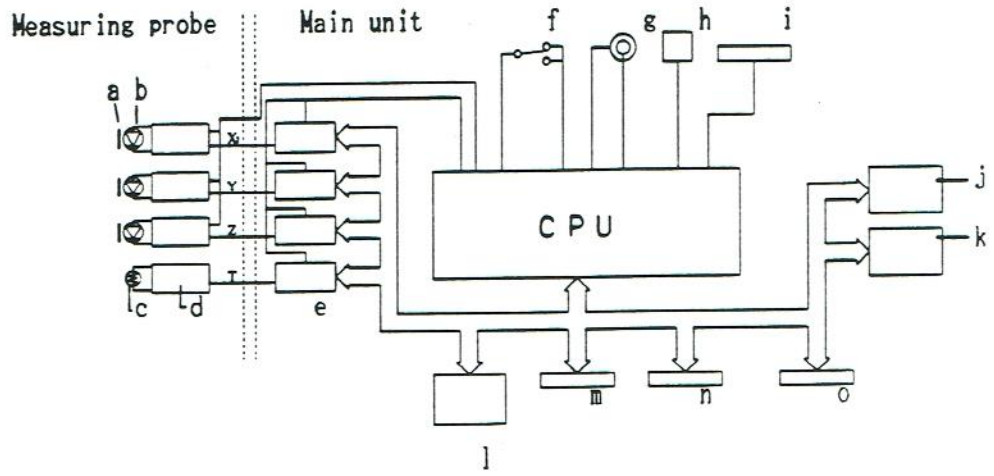
Measurements are performed as follows:

1. The red, green, and blue light emitted by the CRT phosphors enters the receptor area of the measuring probe, passes through the spectral-response correction filters, and strikes the light sensors, which convert the light into currents proportional to the intensity of the light. These currents are then converted into proportional voltages. (Output values: X_2, Y, and Z)
2. At the same time, a temperature sensor outputs a current proportional to the temperature of the measuring probe. This current is then converted into a proportional voltage. (Output value: T)
3. The voltages obtained in step 1 (X_2, Y, and Z) and the voltage obtained in step 2 (T) are passed through A-to-D (analog-to-digital) converters and are changed to digital signals. These A-to-D converters are controlled according to the selected SYNC mode to operate at the proper time for measurement.
4. The resulting digital values (count values) are sent to the CPU of the main unit. (If the Multi-Probe Expansion Board CA-A13 is installed, the digital values will be transferred from all connected measuring probes.) The CPU performs calculations according to the measuring conditions (display mode, SYNC mode, correction factors from calibration to a user-selected reference, etc.) set using the keys and switches.
5. The results of the calculations are shown in the displays and output via the RS-232C terminal. (If the optional GP-IB Interface Board CA-A20 is installed, the data is output according to the IEEE-488 standard via the GP-IB Interface Board instead of the RS-232C terminal.)

SPECTRAL SENSITIVITY



BLOCK DIAGRAM



a. Spectral-sensitivity correction filters
b. Light sensors
c. Temperature sensor
d. Current-to-voltage converters
e. A-to-D converters
f. Luminance-unit selector switch
g. EXT (V. SYNC) terminal
h. Baud-rate selector DIP switches
i. RS-232C terminal
j. Displays
k. Keys
l. Internal memory
m. Connector for optional card
n. Connector for optional Multi-Probe Expansion Board CA-A13
o. Connector for optional GP-IB Interface Board CA-A20

xyY Display Mode

When xyY display mode is set on the main unit, the digital displays show the following values:

x, y: Chromaticity coordinates of CIE 1931 color space
Y: Luminance

The values are calculated according to the following formulas:

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

$$Y = Y$$

X, Y, Z = CIE tristimulus values

- X is determined from the measured X_2 value and the Z value as follows:

$$X = 0.1672Z + X_2 = X_1 + X_2$$

T uvY Display Mode

When TΔuvY display mode is set on the main unit, the digital displays show the following values:

T: Correlated color temperature
Δuv: Color difference from blackbody locus
Y: Luminance

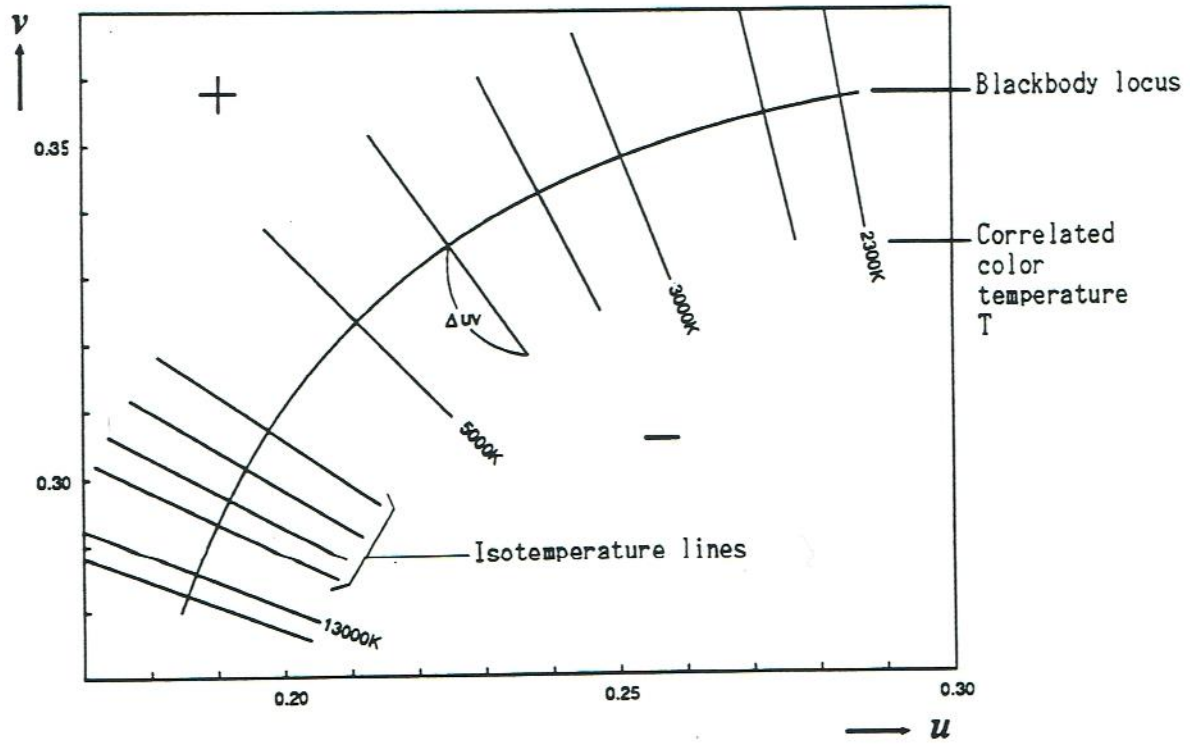
In TΔuvY display mode, color is indicated by correlated color temperature T and color difference from blackbody locus Δuv; luminance is indicated by Y.

RELATION BETWEEN T AND Δuv

The color temperature of a light source is the temperature at which a blackbody (an ideal radiator) would emit light with the same chromaticity. The colors which can be indicated using color temperature are limited to those colors on the blackbody locus.

Correlated color temperature is used to apply the general idea of color temperature to those colors that are close to but not exactly on the blackbody locus. The correlated color temperature is determined by determining the isotemperature line on which the color of the light source is positioned. Isotemperature lines are straight lines for which all colors on the line appear visually equal; the correlated color temperature of any color on the isotemperature line is equal to the color temperature at the point where the isotemperature line intersects the blackbody locus.

Since all colors on an isotemperature line have the same correlated color temperature, it is necessary to also specify the difference from the blackbody locus Δuv to completely describe a color. A positive (+) value of Δuv indicates a color which is above the blackbody locus; a negative (-) value indicates a color which is below the blackbody locus.



Relation Between Correlated Color Temperature and Δuv

Calibration to a User-Selected Reference

Calibration to a user-selected reference is performed by measuring a color generated on a CRT and inputting the calibration values (x, y, Y) for the generated color into the CA-100. The CA-100 then determines the correction factors to be applied to the measured values in order to match the calibration values, and stores the correction factors in the selected memory channel.

At the time of shipment, all memory channels are set to Minolta's standard calibration values, and measurements can be taken immediately based on Minolta's standard. Calibration to a user-selected reference can be performed to determine the correction factors for the following situations:

a. To correct for slight differences between the spectral sensitivities of the measuring probe's sensors and the CIE 1931 color-matching functions.
   The measuring probe contains three sensors to measure the color on the CRT screen. The spectral sensitivities of these sensors are close to the CIE 1931 color-matching functions, but are not exactly the same. Because of this, the measured absolute values will be influenced by the slight differences between the spectral sensitivities of the sensors and the CIE 1931 color-matching functions, and will thus be slightly different than the true values based on the CIE 1931 color-matching functions. By generating a color with known values on a standard CRT and performing calibration to this reference color, the influence of the slight differences between spectral sensitivities of the measuring probe's sensors and the CIE 1931 color-matching functions can be effectively eliminated.
b. To standardize the spectral response of several CA-100 units (or measuring probes when using the optional Multi-Probe Expansion Board CA-A13).
   Even between different units of the same type of measuring probe, the spectral sensitivities of the sensors of the different units may vary slightly. Because of this, the displayed measurement values for different units may be slightly different even if the same CRT is measured. If calibration to a user-selected reference is performed for several units using the same CRT and calibration values, the influence of slight inter-instrument differences in spectral sensitivities can be effectively eliminated.

The correction factors α, β, and γ, which are stored in the selected memory channel of the CA-100 (but which cannot be directly recalled to the display) are calculated according to the following procedure.

a. The values (x_0, y_0, Y_0) measured based on Minolta's standard calibration are used to calculate the internal measured values X_2, Y, and Z.

$$X_2 = \frac{1.1672x_0 + 0.1672y_0 - 0.1672}{y_0} Y_0$$

$$Y = Y_0$$

$$Z = \frac{1 - x_0 - y_0}{y_0} Y_0$$

b. The values of X_2, Y, and Z and the calibration values for the user-selected reference (x_1, y_1, Y_1) are then used to calculate the correction factors α, β, and γ.

$$\alpha = \frac{1}{X_2} \frac{1.1672x_1 + 0.1672y_1 - 0.1672}{y_1} Y_1$$

$$\beta = \frac{Y_1}{Y}$$

$$\gamma = \frac{1}{Z} \frac{1 - x_1 - y_1}{y_1} Y_1$$

The correction factors α, β, and γ are used to calculate internal corrected values X_2', Y', and Z' as follows:

$$X_2' = \alpha X_2$$

$$Y' = \beta Y$$

$$Z' = \gamma Z$$

These internal corrected values (X_2', Y', Z') are then used to calculate the displayed and output values (x, y, Y) as follows:

$$x = \frac{X_2' + 0.1672Z'}{X_2' + Y' + 1.1672Z'}$$

$$y = \frac{Y'}{X_2' + Y' + 1.1672Z'}$$

$$Y = Y'$$

Analyzer Mode

Inserting an optional Analyzer Card adds analyzer display mode to the CA-100.

In analyzer mode, the CA-100 displays the luminous intensities (brightnesses) of the monochromatic red, green, and blue colors in relation to the values previously stored in memory for the RGB emission characteristics of the CRT phosphors and the standard white W. Since the luminous intensities of the monochromatic red, green, and blue colors can be adjusted individually by adjusting the screen voltage and drive voltage for each color, analyzer mode makes adjusting the white balance of the CRT much easier.

The sensors of the measuring probe are filtered to have spectral sensitivities $\bar{x}_2\lambda$, $\bar{y}\lambda$, and $\bar{z}\lambda$, which are somewhat related to the CRT's RGB spectral distribution as shown in figure 1. Actually, the spectral distribution of any color generated on the CRT screen will have some area which coincides with the spectral sensitivity of each of the measuring probe's three sensors. For example, if monochromatic red is generated on the CRT, some area of the spectral distribution of the generated red will coincide with the spectral sensitivity of each of the three sensors as indicated by the shaded areas in figure 2. The same principle applies to monochromatic green or monochromatic blue.

To measure each monochromatic color separately, it would seem that some kind of special device would be necessary. In analyzer display mode, the CA-100 provides a solution to this problem based on measurement as follows.

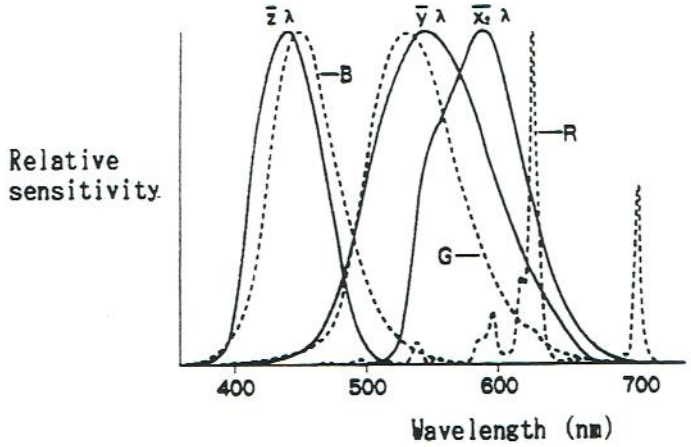


Figure 1: Relation between typical CRT spectral distribution and spectral sensitivities of CA-100 measuring-probe sensors

When monochromatic red is generated on the CRT, the outputs X_{2R}, Y_R, and Z_R for $\bar{x}_2\lambda$, $\bar{y}\lambda$, and $\bar{z}\lambda$ are as indicated by the shaded areas in figure 2. The output from each sensor is then stored in memory and used to adjust the output of each sensor during later measurements of luminous intensity. The output ratio (the portion of sensor output due to red) is different for different sensors and CRTs.

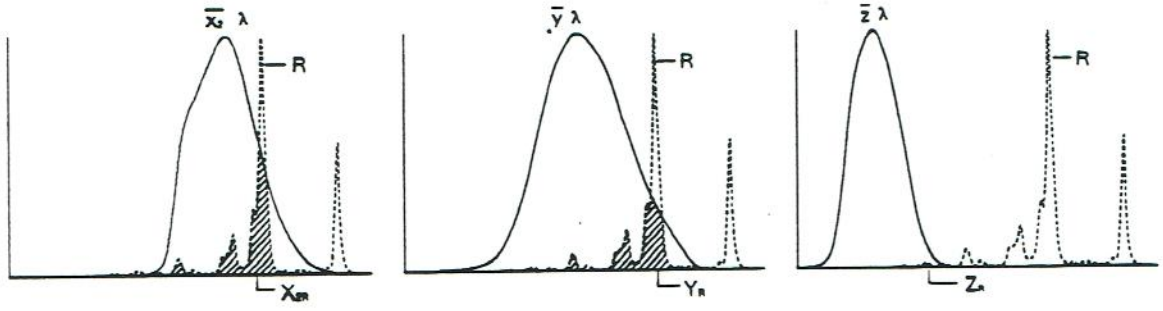


Figure 2: Sensor output when measuring monochromatic red generated on a CRT

The same principle is used to determine the output ratios for green (figure 3) and blue (figure 4) as shown below.

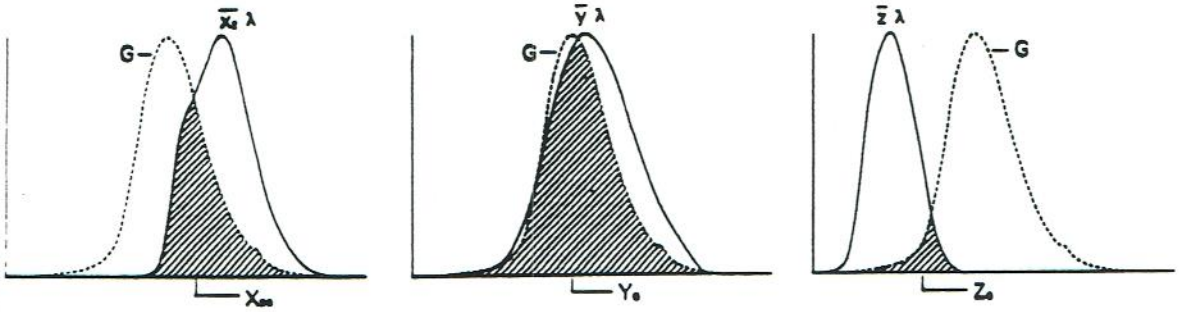


Figure 3: Sensor output when measuring monochromatic green generated on a CRT

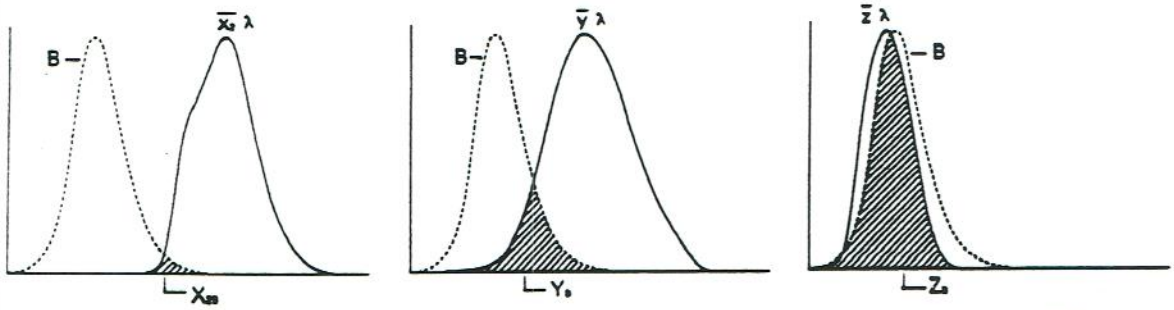


Figure 4: Sensor output when measuring monochromatic blue generated on a CRT

By measuring each monochromatic color separately and determining the appropriate constants for calculations based on the output ratio of each sensor for each color, the luminous quantity of each color can be determined from the total output of each sensor even when all three colors are generated at the same time. When measurements are taken, the luminous intensity for each color is displayed relative to the standard color (W), for which the relative value of each color is 100.

To perform measurements in analyzer mode according to the above procedure, it is necessary to store the RGB emission characteristics of the CRT phosphors and the standard white value in memory before measurements. Also, since the RGB emission characteristics are different for different types of CRTs, the memory channel which is used for measurements should contain the RGB emission characteristics for the type of CRT which is being measured.

CARE AND STORAGE

- If the CA-100 becomes dirty, it may be wiped with a soft, clean, dry cloth or silicon-treated cloth. Never use benzene, paint thinner, or other chemicals to clean the CA-100.
- If the diffuser plate of the measuring probe's receptor area becomes dirty, it may be wiped lightly with a soft, clean cloth or photographic lens tissue.
- Do not disassemble the CA-100 or attempt to repair it yourself. If repairs are required, contact the nearest Minolta service facility.
- Do not use the CA-100 under conditions which may result in condensation. Be especially careful to protect the CA-100 when transporting it from a cold area to a warm, humid area.
- The storage temperature range for the CA-100 and optional accessories are as follows:

CRT Color Analyzer CA-100 and standard accessories Multi-Probe Expansion Board CA-A13 GP-IB Interface Board CA-A20	-20 to 55°C (-4 to 131°F)
Memory or Analyzer Cards	-10 to 55°C (14 to 131°F)

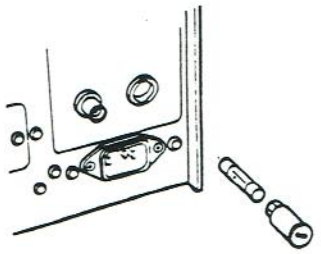
Do not store the CA-100 or any of the optional accessories in areas subject to high temperatures or high humidity. If possible, store the CA-100 and/or the optional accessories at room temperature together with a drying agent such as silica gel.

- Do not store the optional Memory or Analyzer cards in areas subject to static electricity or large amounts of electrical noise. Storage in such areas may result in stored data being damaged.
- When storing the optional Multi-Probe Expansion Board CA-A13 or GP-IB Interface Board CA-A20, they should be placed in the protective anti-static bags in which they were shipped.

FUSE REPLACEMENT

The CA-100 is equipped with a fuse to protect it from power surges. If the fuse blows, it should be replaced with a fuse of the same type and rating (0.5A/250V time-delay fuse for 100-120V AC model; 0.315A/250V time-delay fuse for 200-240V AC model) according to the following procedure.

1. Set POWER switch to **OFF** and unplug the AC power cord.
2. Using a slotted (straight-tip) screwdriver, turn the screw of the fuse holder counterclockwise as shown until it is free of the main body.
3. Remove the blown fuse and insert a replacement fuse of the same type and rating.
4. Replace fuse holder and use the slotted screwdriver to turn the fuse-holder screw clockwise until snug.

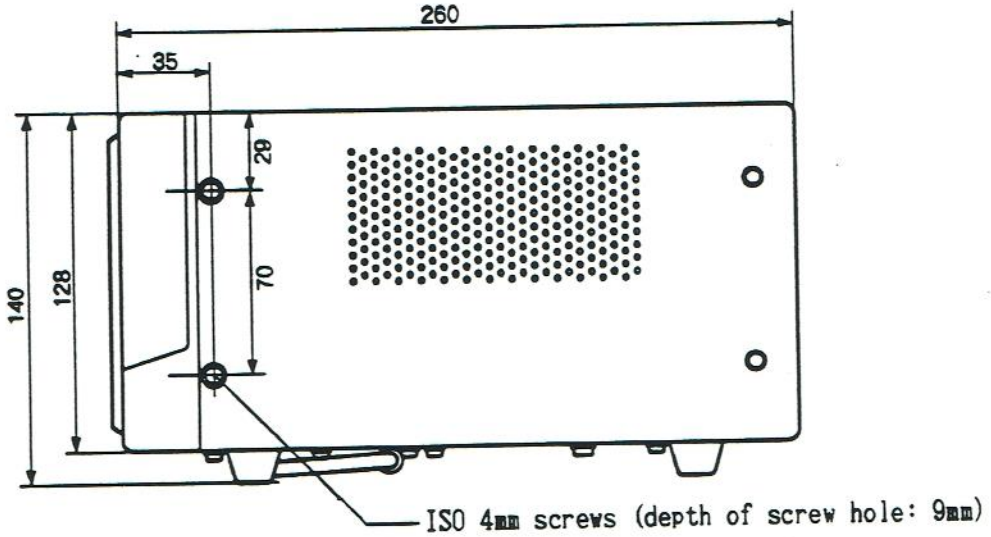


- If the new fuse blows immediately, unplug the AC power cord and contact the nearest Minolta authorized service facility.

RACK INSTALLATION

The CA-100 can be installed in a rack which conforms to EIA (Electronic Industries Association) standards.

Each side of the main unit has two ISO 4mm screws (total: four) toward the front of the unit. These screws can be removed and their screw holes can be used for mounting the main unit in a rack. Some additional hardware may be required. Refer to the diagram below for the positioning of the holes.

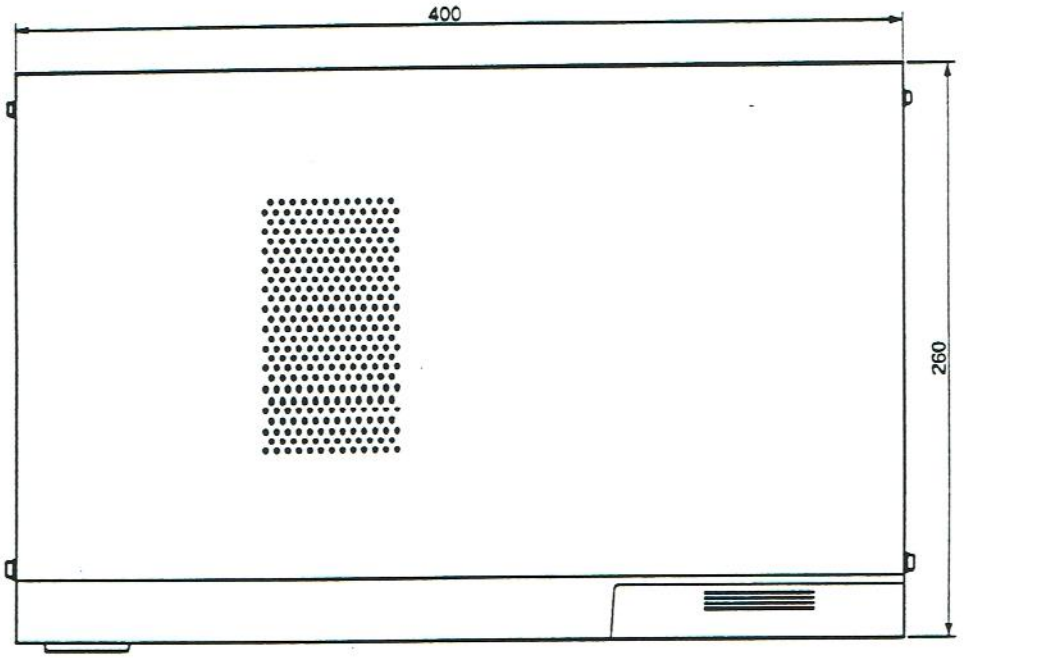


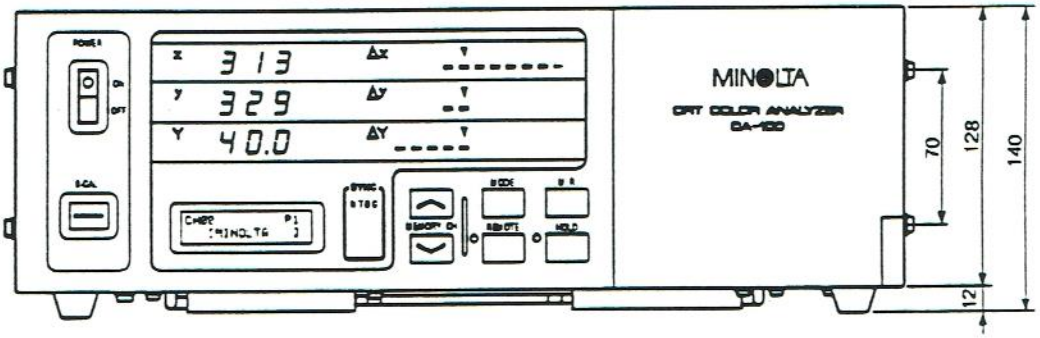
- Be sure that the rack and all associated hardware are sufficiently strong to support the CA-100.
- Be sure that there is sufficient ventilation for the CA-100.

DIMENSIONS

Main Body

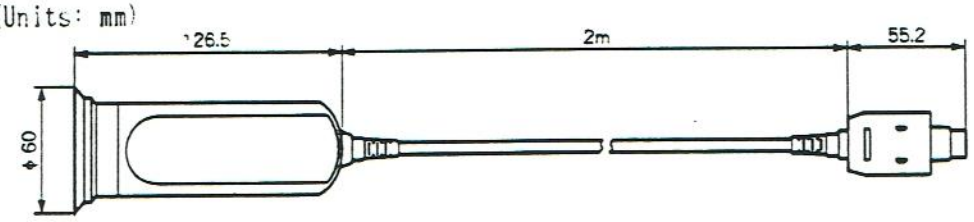
(Units: mm)

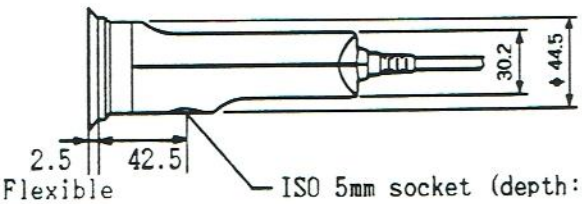




Measuring Probe

(Units: mm)





ERROR MESSAGES

Error message	Cause	Solution
E1 CH01 P1 E1 [ ]	Display mode: xyY or T⊿uvY ● No standard color data has been set in the selected memory channel after shipment.	Perform calibration to a user-selected reference or set standard color data.
	● The measuring probe which is being used is different from the measuring probe which was used for calibration to a user-selected reference or setting of standard color data.	Use the presently connected measuring probe to perform calibration to a user-selected reference or set the standard color data, or change the measuring probe to the one that was used when calibration to a user-selected reference or setting of standard color data was performed.
	Display mode: Analyzer (RBG) ● There are no RGB emission characteristics of CRT phosphors presently set in the selected memory channel. At the time of shipment no RGB emission characteristics are stored in memory.	Set RGB emission characteristics.
	● Measuring probe presently being used is different from the measuring probe used when RGB emission characteristics or standard color data were set.	Use the measuring probe which was used when RGB emission characteristics or standard color data were set, or set RGB emission characteristics or standard color data using the present measuring probe.
	Data stored in the presently selected memory channel was lost.	Perform required procedures to set calibration data for a user-selected reference, standard color data, or RGB emission characteristics again.
	Note: To quickly determine the exact cause of the error, check the serial number of the present probe and that of the probe used when calibration to a user-selected reference or setting of standard color (or setting of RGB emission characteristics of CRT phosphors) was performed and refer to p. 93. Error message "E2" will not appear when this error message is shown.	
E2 CH01 P1 E2 [ ]	Ambient temperature has changed since zero calibration was performed.	Perform zero calibration again.
	Note: This display will not appear in the liquid crystal display when "E1" is shown.	

Error message	Cause	Solution
E3 CH01 x y Y E3 330 000 39.5	Unacceptable calibration data (when performing calibration to a user-selected reference) or standard color data (when inputting standard color data for memory channel 00 using the number keys) was input. Unacceptable data includes the following: x, y, or Y = 0 x + y ≥1 Y ≥1000cd/m^2 (292 fL) Other data which is contradictory or which exceeds the processing capability of the CA-100.	Input correct data and press **ENTER** again.
E4 RANGE x,y Y E4(%) 0.0 2.0	"0.0%" was entered as the analog display range value.	Use the number keys (0 through 9) and . to set a value between 0.1 and 99%, and then press **ENTER** again.
E5 CH01 E5 W *R *G *B	● At least one of the values (R, G, B, or W) has not been input.	Input all four values (R, G, B, and W) and then press **ENTER**.
	● The measured standard color (W) was over the measuring range when 7 was pressed.	Set the standard color (W) within the measuring range, press 7 again, and then press **ENTER**.
OFFSET ERROR OFFSET ERROR PUSH 0-CAL KEY	Zero calibration was not performed correctly (all light was not blocked from reaching the receptor area of the measuring probe before zero calibration was performed).	Perform zero calibration again. Be sure that no light reaches the receptor area of the measuring head until zero calibration has been completed.
	Note: When this message appears: - CA-100 will not respond if **CAL** is pressed. - Calibration mode will be canceled. - ID label input mode will be canceled. - Analog display range setting mode will be canceled. - Mode for setting RGB emission characteristics will be canceled. Measured data will appear in the displays if light reaches the receptor area of the measuring probe; however, data will not be correct.	
TOO BRIGHT TOO BRIGHT	Some light reached the receptor area of the measuring probe during zero calibration.	Block all light from reaching the receptor area of the probe and press **0-CAL** again after "DARKEN PROBE PUSH 0-CAL KEY" appears in the display.

Error message	Cause	Solution
NO SYNC. SIGNAL NO SYNC.SIGNAL	● SYNC mode is set to EXT and no external synchronization signal is being input via the EXT (V. SYNC) terminal on the back of the CA-100.	Input an external synchronization signal.
	● The frequency of the synchronization signal being input is less than 40Hz.	**Set SYNC mode to UNIV.**
	Note: When this message appears: - CA-100 will not respond if **CAL** is pressed. - CA-100 will not respond if **ENTER** is pressed while calibration LED is lit. - CA-100 will not respond if **HOLD** is pressed.	
OVER OVER	● Measured value is beyond the measuring range of the CA-100. ● In analyzer mode, the calculated measurement value is greater than 100,000% (over display range).	Set a color within the CA-100's measuring range. Set a color within the CA-100's display range.
SET MAIN PROBE SET MAIN PROBE	Measuring probe is not correctly connected to probe connector P1.	Set POWER switch to **OFF**, connect measuring probe correctly to probe connector P1, and set POWER switch to **ON** again.
PROBE ERROR PROBE ERROR	Measuring probe was connected or disconnected while CA-100 was switched on.	Set POWER switch to **OFF**, reconnect measuring probe, and set POWER switch back to **ON**.
MEMORY CARD ERROR MEMORY CARD ERROR	● Memory card was inserted or removed while CA-100 was switched on.	Set POWER switch to **OFF** and reinsert card.
	● A card other than CA-100 optional cards was inserted.	Use only optional cards specifically designed for the CA-100.
	● Memory Card CA-A14, Analyzer Card-G CA-A15, or Analyzer Card-R CA-A16 was inserted when using optional Multi-Probe Expansion Board CA-A13 with more than one measuring probe connected to the CA-100.	Set POWER switch to **OFF**, insert the appropriate card, and set POWER switch back to **ON**.

Error message	Cause	Solution
DATA ERROR DATA ERROR	Measurement circuit is not operating correctly.	Set POWER switch to **OFF** and then set it back to **ON**. If this display reappears, the CA-100 is malfunctioning. Contact the nearest Minolta service facility.
	Note: **When this message appears:** - **CA-100 will not respond if CAL is pressed.** - **Calibration mode will be canceled.** - **ID label input mode will be canceled.** - **Analog display range setting mode will be canceled.** - **Mode for setting RGB emission characteristics will be canceled.** - **Data in all memory channels (standard color data, calibration data for user-selected reference, ID label, etc.) will be reset to their initial settings (settings at time of shipment).**	
MEMORY ERROR MEMORY ERROR	Memory error.	Set POWER switch to **OFF** and then set it back to **ON**. If this display reappears, the CA-100 is malfunctioning. Contact the nearest Minolta service facility.

Determining Cause of Error Message "E1"

When error message "E1" appears, check the serial numbers of the present measuring probe and the measuring probes used for calibration to a user-selected reference, setting RGB emission characteristics of CRT phosphors, and setting the standard color data. Then check the results against the table below and on the following page.

To check the serial number of the present measuring probe, press **PROBE**. (When using optional Multi-Probe Expansion Board CA-A13, the presently selected measuring probe connector will also change when **PROBE** is pressed.)

To check the serial numbers of the measuring probes used for calibration to a user-selected reference (or for setting RGB emission characteristics of CRT phosphors when using an optional Analyzer Card) and for setting the standard color data, press **PROBE** while holding **M R** pressed. Two serial numbers will appear in the liquid crystal display: the upper serial number is the serial number of the measuring probe used for performing calibration to a user-selected reference (if xyY or TΔuvY display mode is selected) or for setting RGB emission characteristics of CRT phosphors (if analyzer (RBG) display mode is selected); the lower serial number is the serial number of the measuring probe used for setting the standard color data.

Serial numbers of measuring probes for setting data (**PROBE** pressed while **M R** held pressed)	xyY or TΔuvY display mode	Analyzer (RBG) display mode
Both numbers "00000000" 00000000 00000000	Cause: Calibration to a user-selected reference and setting of standard color data has not been performed for the selected memory channel since the CA-100 was shipped from the factory. Solution: Perform calibration to a user-selected reference or set standard color data for the selected memory channel.	Cause: Setting of RGB emission characteristics of CRT phosphors or setting of standard color data has not been performed for the selected memory channel since the CA-100 was shipped from the factory. Solution: Set RGB emission characteristics of CRT phosphors or set standard color data for the selected memory channel.
Upper number "00000000"; lower number any value except "00000000" or "99999999" 00000000 16790160		Cause: RGB emission characteristics of CRT phosphors have not been set. Solution: Set RGB emission characteristics of CRT phosphors. If it is desired to set the standard color data to different data than the data set when RGB emission characteristics are set, set the desired standard color data after setting the RGB emission characteristics.

Serial numbers of measuring probes for setting data (PROBE pressed while M R held pressed)	xyY or TΔuvY display mode	Analyzer (RBG) display mode
Upper and lower numbers different 21593001 16790160	Cause: The measuring probe used for performing calibration to a user-selected reference was different from the measuring probe used for setting standard color data. Solution: Set standard color data using the measuring probe with which calibration to a user-selected reference was performed. Alternately, use the presently connected measuring probe to perform calibration to a user-selected reference or to set standard color data.	Cause: The measuring probe used for setting RGB emission characteristics of CRT phosphors was different from the measuring probe used for setting standard color data. Solution: Set standard color data using the measuring probe with which RGB emission characteristics of CRT phosphors were set. Alternately, use the presently connected measuring probe to set RGB emission characteristics of CRT phosphors and to set standard color data.
Upper and lower numbers same 16790160 16790160	Cause: The present measuring probe is different from the measuring probe used for performing calibration to a user-selected reference or for setting standard color data. Solution: Take measurements using the measuring probe with which calibration to a user-selected reference was performed or standard color data were set. Alternately, use the present measuring probe to perform calibration to a user-selected reference or to set standard color data.	Cause: The present measuring probe is different from the measuring probe used for setting RGB emission characteristics of CRT phosphors or for setting standard color data. Solution: Take measurements using the measuring probe with which RGB emission characteristics or standard color data were set. Alternately, use the present measuring probe to set RGB emission characteristics or to set standard color data.
Upper number "00000000" and lower number "99999999" 00000000 99999999	**Cause: Data stored in the selected memory channel was destroyed. Correction factors and ID label are set to the values set at the time of shipment.** **Solution: Perform all operations necessary to set the desired data again.**	**Cause: Data stored in the selected memory channel was destroyed. ID label set to the value set at the time of shipment.** **Solution: Perform all operations necessary to set the desired data again**

TROUBLESHOOTING GUIDE

If a problem occurs with the CA-100, please check the following points before requesting service. If the problem continues after checking these points and taking the appropriate corrective action, contact the nearest Minolta service facility.

Problem	Checkpoint	Solution
After POWER switch has been set to **ON**, nothing appears in the liquid crystal display.	Is AC power cord connected properly?	Set POWER switch to **OFF** and connect AC power cord properly. See p. 20.
	Is fuse inserted?	Insert fuse. See p. 87.
	Is fuse blown?	Replace blown fuse with a new one. See p. 87.
	Is power source correct (AC 100 to 120V, 50 to 60Hz for North America, AC 220 to 240V, 50 to 60Hz for Europe)?	Connect AC power cord to the correct power source.
CA-100 does not respond when a key is pressed.	Is CA-100 in remote-control mode (is REMOTE LED lit)?	Press **REMOTE** to cancel remote-control mode (REMOTE LED will become not lit).
	Can the key be used in the present operation?	Press a key which can be used in the present operation.
Even after zero calibration has been performed, "ZERO CALIBRATION" continues to be shown in the liquid crystal display.		Set POWER switch to **OFF** and then set it back to **ON**. If this situation continues even after zero calibration is performed again, the CA-100 is malfunctioning.
Even though no light was allowed to reach the receptor area of the measuring probe when zero calibration was performed, "TOO BRIGHT" appears in the liquid crystal display.		Set POWER switch to **OFF** and then set it back to **ON**. If this situation continues even after zero calibration is performed correctly again, the CA-100 is malfunctioning.
When SYNC mode is set to EXT, "NO SYNC SIGNAL" appears in the liquid crystal display.	Is an external synchronization signal source connected properly to the CA-100's EXT (V. SYNC) terminal and is a synchronization signal being input?	Connect the external synchronization signal source properly and input the synchronization signal correctly. See p. 16.
	Does the synchronization signal being input meet the input signal requirements?	Input a synchronization signal which meets the input signal requirements. See p. 16.
	Is the frequency of the synchronization signal being input between 40 and 90Hz?	**Set SYNC mode to UNIV. See p. 22.**

Problem	Checkpoint	Solution
When performing calibration to a user-selected reference, the values input before calibration and the values shown in the display after calibration are different.	Is the luminance (Y value) of calibration data low?	When the calibration luminance value is low, the values may become different due to rounding off during internal calculations.
Measured values vary widely.	Is the selected SYNC mode appropriate for the CRT being measured?	Select the appropriate SYNC mode. See p. 22.
	Is the luminance of the CRT low?	When measuring a CRT of low luminance, the x, y repeatability is lower.
	Is receptor area of measuring probe being held firmly in one position against the CRT surface?	Hold the receptor area of measuring probe firmly against the CRT surface and do not move it during measurements.
Displayed measurement values seem incorrect.	Is receptor area of measuring probe dirty?	Clean receptor area of measuring probe with a soft, dry cloth or silicon-treated cloth.
	Did ambient temperature change?	Perform zero calibration at present ambient temperature. See p. 26.
	Was calibration to a user-selected reference performed properly?	Perform calibration to a user-selected reference properly. See p. 33.
	Is luminance-unit selector switch set to the desired position?	Set luminance-unit selector switch to the desired position. See p. 22.
Values indicated by analog display do not change.	Is analog display range set properly?	Set analog display range properly. See p. 39.
	Are standard color data set properly?	Set standard color data properly. See p. 30 for setting or changing standard color data. Standard color data are also automatically set when calibration to a user-selected reference is performed (see p. 33) or when RGB emission characteristics of CRT phosphors are set (see p. 36).

Problem	Checkpoint	Solution
When performing data communication via the RS-232C terminal, data output by the CA-100 are not received by the computer, or commands or data from the computer are not received by the CA-100.	Is the cable connecting the CA-100 and the computer connected properly to both units?	Connect cable properly to both the CA-100 and the computer. See p. 50.
	Are the internal connections of the connecting cable correct?	Check that the internal connections of the connecting cable are the same as those shown on p. 50.
	Are the communication parameters set on the computer the same as those of the CA-100?	Set the communication parameters of the computer to those of the CA-100. See p. 51.
	Is remote-control mode of CA-100 switched off (is REMOTE LED not lit)?	Press **REMOTE** or input the command "F1" from the computer to switch on the CA-100's remote-control mode.
	Is the optional GP-IB Interface Board CA-A20 installed in the CA-100?	Remove the GP-IB Interface Board from the computer. See p. 58. (While GP-IB Interface Board is installed, data communication via the RS-232C terminal is not possible.)
	Is the computer program correct?	Check operation using the sample program in this manual. See p. 54.
While performing data communication via the RS-232C terminal, even if **REMOTE** is pressed, remote-control mode is not set (REMOTE LED does not light).	Is the optional GP-IB Interface Board CA-A20 installed in the CA-100?	Remove the GP-IB Interface Board from the CA-100. See p. 58. (While GP-IB Interface Board is installed, data communication is possible only via the GP-IB system.)
The error message "DATA ERROR" or "MEMORY ERROR" appears in the liquid crystal display.		Set POWER switch to **OFF** and then set it back to **ON**. If either of these error messages continues to appear, the CA-100 is malfunctioning.

When Using Optional Multi-Probe Expansion Board

Problem	Checkpoint	Solution
Probe connectors P2 through P5 cannot be selected (do not appear in the liquid crystal display).	Is Multi-Probe Expansion Board properly installed?	Install Multi-Probe Expansion Board properly.
	Are measuring probes properly connected to probe connectors P2 through P5?	Connect measuring probes properly to those probe connectors which will be used. Only those probe connectors to which measuring probes are properly connected can be selected.

When Using an Optional Memory Card or Analyzer Card

Problem	Checkpoint	Solution
Card does not function properly.	Is card being used one of the optional cards for the CA-100?	Use only optional Memory or Analyzer Cards specifically designed for the CA-100.
	Is the correct card being used? (Optional Memory Card CA-A14, Analyzer Card-G CA-A15, and Analyzer Card-R CA-A16 are for use when the measuring probe connected to probe connector P1 is the only measuring probe connected to the CA-100; Multi-Probe Memory Card CA-A17, Multi-Probe Analyzer Card-G CA-A18, and Multi-Probe Analyzer Card-R CA-A19 are for use only when Multi-Probe Expansion Board CA-A13 is installed in the CA-100.)	Use the correct card.
	Is the card fully inserted in the proper orientation?	Insert card fully in the proper orientation.

When Using Optional GP-IB Interface Board CA-A20

Problem	Checkpoint	Solution
When performing data communication via the GP-IB terminal, data output by the CA-100 are not received by the controller (computer), or commands or data from the controller (computer) are not received correctly by the CA-100.	Is the cable connecting the CA-100 and the controller (computer) connected properly to both units?	Connect cable properly to both the CA-100 and the controller (computer). See p. 59.
	Is the address properly set?	Set the address properly. See p. 59.
	Is remote-control mode of CA-100 switched off (is REMOTE LED not lit)?	Set REN signal low to designate CA-100 as a listener. When data is output from CA-100 to controller (computer), designate CA-100 as a talker. See p. 60.
	Is GP-IB Interface Board properly installed?	Install GP-IB Interface Board properly. See p. 58.
	Is the computer program correct?	Check operation using the sample program in this manual. See p. 64.
	Is delimiter code properly set?	Set delimiter code properly on CA-100 and controller (computer). See p. 62.
	Is service request properly set?	Set service request properly on CA-100 and controller (computer). See p. 61.
	Are other devices connected to the GP-IB system operating properly?	Reset all devices connected to the GP-IB system.

SPECIFICATIONS

Type:	CRT color analyzer
Luminance measuring range:	0.20 to 999cd/m^2 or 0.06 to 292fL; luminance units selectable via switch on back panel
Display modes:	xyY; TΔuvY; analyzer (RBG) mode (green standard or red standard)*
Synchronization modes:	NTSC; PAL; EXT; UNIV.
Display values:	Digital: xyY; TΔuvY; analyzer (RBG)* Analog: $\Delta x \Delta y \Delta Y$; R/G, B/G, ΔG*; ΔR, B/R, G/R*
Memory:	11 channels; 100 channels with memory card*
Accuracy:	Y: $\pm$2% $\pm$1 digit xy: $\pm$0.002 (Measurement conditions: standard monitor, luminance 10.0cd/m^2 or above, D_{65})
Repeatability:	Y: $\pm$0.3% $\pm$1 digit xy: $\pm$1% $\pm$1 digit (0.20cd/m$^2 \leq Y \leq$ 3.00cd/m^2) $\pm$0.3% $\pm$1 digit (3.00cd/m$^2 <$ Y $\leq$ 999cd/m^2)
Measurement rate:	NTSC: 10 times/s PAL: 8 times/s EXT: 7 times/s (for 60Hz synchronization signal) UNIV.: 5 times/s (Measurement conditions: Display mode: xyY, measuring probe connected to probe connector P1 only, baud rate: 9600)
Other functions:	Calibration to user-selected reference; storage of ID name; user-variable analog display range; analyzer mode*; simultaneous measurements of multiple points*
Data communication:	RS-232C interface (baud rate: 300 to 19200bps, set to 9600bps at factory); GP-IB (IEEE-488)*
Operating temperature range:	0 to 40°C (32 to 104°F); 85% humidity (at 35°C/95°F with no condensation)
Power:	AC 100 to 120V, 50/60Hz, 40VA or AC 200 to 240V, 50/60Hz, 40VA
Dimensions:	Main unit: 400 x 140 x 260mm (15-3/4 x 5-1/2 x 10-1/4 in.) Measuring probe: ø45 x 127mm (ø1-3/4 x 5 in.) Cord length: 2m (6.6 ft.)
Weight:	Main unit: 5.5kg (12.1 lb.) Measuring probe: 250g (8-13/16 oz.)
Standard accessories:	Measuring Probe CA-A10 (with 2m/6.6 ft. cord), AC power cord, Measuring Probe Holder CA-A11, fuse (1), basic operation sheets (5 sheets; can be stored inside keyboard cover)
Optional accessories:	Measuring Probe CA-A10 (with 2m/6.6 ft. cord), Measuring Probe CA-A12 (with 5m/16.4 ft. cord), Multi-Probe Expansion Board CA-A13, GP-IB Interface Board CA-A20, Memory Card CA-A14, Multi-Probe Memory Card CA-A17, Analyzer Card-G CA-A15, Analyzer Card-R CA-A16, Multi-Probe Analyzer Card-G CA-A18, Multi-Probe Analyzer Card-R CA-A19

* Function available with optional accessory only

Specifications subject to change without notice